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RESULTS OF TESTS OF ADVANCED FLEXIBLE REUSABLE SURFACE INSULATION VORTEX AND FLOW ENVIRONMENTS IN THE NORTH AMERICAN AERODYNAMICS LABORATORY LOWSPEED WIND TUNNEL USING 0.0405-SCALE SPACE SHUTTLE ORBITER MODEL 16-0 (TEST OA-309)

by

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Prepared under NASA Contract Number NAS9-16283

by

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for

Systems Engineering Division

Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas

WIND TUNNEL TEST SPECIFICS:

Test Number:	NAAL 838
Tunnel:	NAAL Lowspeed Wind Tunnel
NASA Series Number:	OA-309
Model Number:	16-0
Test Dates:	4-25-83 through 5-9-83 and 8-23-83 through 8-24-83
Occupancy Hours:	104

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ABSTRACT

An experimental investigation (Test OA-309) was conducted using 0.0405-scale Space Shuttle Orbiter Model 16-O in the North American Aerodynamics Laboratory 7.75 x 11.00-foot Lowspeed Wind Tunnel during the time period of April 25 through May 9, 1983 and August 23 through August 24, 1983. The primary purpose of this investigation was to locate and study any flow conditions or vortices that might have caused damage to the Advanced Flexible Reusable Surface Insulation (AFRSI) during the Space Transportation System STS-6 mission. A secondary objective was to evaluate vortex generators to be used for Wind Tunnel Test OS-314.

Flowfield visualization was obtained by means of smoke, tufts, and oil flow. The test was conducted at Mach numbers between 0.07 and 0.23 and at dynamic pressures between 7 and 35 pounds per square foot. The angle-of-attack range of the model was -5 degrees through 35 degrees at 0 or 2 degrees of sideslip, while roll angle was held constant at zero degrees. The vortex generators were studied at angles of 0, 5, 10, and 15 degrees.

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INTRODUCTION

Wind Tunnel tests were initiated as a result of the OV-099 OMS pod AFRSI-panel failure which occurred during STS-6 entry. The AFRSI failed at the leading edge outboard corner of both OMS pods during STS-6 entry. To locate and study any flow conditions or vortices around the orbiter vehicle which might have caused damage to the AFRSI, Low Speed wind tunnel tests of a 0.0405-scale SSV orbiter model 16-O were conducted. The tests were conducted in the Rockwell NAAL 7.75 x 11.00-foot Lowspeed Wind Tunnel in the time period of April 25 thorugh May 9, 1983, and from August 23 through August 24, 1984. These tests are numbered OA-309.

A secondary objective of these tests was to investigate the vortex shedding from a variety of vortex generator designs to determine which (if any) most closely simulated the vortex flowfield around the OMS pod. The chord lengths, camber, and span were varied in the four different vortex generator designs used for these tests. Data obtained from this portion of the test were used to determine the candidate vortex generators for use in a follow-on OMS AFRSI test (OS-314) in the ARC 9x7-foot wind tunnel.

Smoke, tufts, and oil flow studies were conducted as a means of obtaining flowfield visualization. Acoustic pressure transducers (Kulites) were used to measure the sound pressure levels of the aero-acoustic environment and an eleven-tube total pressure rake provided boundary layer profiles near the OMS pod and at two locations on the wing.

This test was conducted at Mach numbers between 0.07 and 0.23 and at dynamic pressures of 7, 10, 35, 60, and 80 psf. The angle of attack range of the model was -5 degrees through 35 degrees at 0 or 2 degrees of sideslip, while roll

angle was held constant at zero degrees. The vortex generators were studied at angles of attack of 0, 5, 10, and 15 degrees.

All test objectives were met. This report contains information on the conduct of Test OA-309, descriptions of the test facility, instrumentation details, and data collected during the test. Photographs of the 0.0405-scale Space Shuttle Orbiter Model 16-O are also included.

NOMENCLATURE

Symbol	Definition
b	Span, inches
$\bar{c}$	Mean aerodynamic chord, inches
C_p	Pressure coefficient
Deg., deg., $^\circ$	Degrees
$^\circ$F	Degrees Fahrenheit
Ft, ft	Feet
IN., In., in.	Inches
P5 through P15	Pressure coefficient at boundary layer-rake tubes 5 through 15
PSF, psf	Pounds per square foot
PSFA	Absolute pressure, PSF
PSI, psi	Pounds per square inch
PSIA	Absolute pressure, psi
PT	Total/stagnation pressure, psi
Pt.	Point
q_ℓ	Local dynamic pressure, PSF
Q, q_o	Freestream dynamic pressure, PSF
sec	Seconds
sq.	Square
V5 through V15	Velocity at boundary-layer rake tubes 5 through 15, feet per second
V_ℓ	Local velocity, feet per second
V_o	Freestream velocity, feet per second
X_o	Orbiter longitudinal station, inches
Y_o	Orbiter lateral buttplane, inches
Z_o	Orbiter vertical waterplane, inches

Symbol	Definition
α	Angle of attack in degrees
$\measuredangle^{\circ}$	Angle of vortex generator, degrees
$\Lambda_{L.E.}$	Sweep angle of the leading edge, degrees
ρ_o	Freestream density, slugs per ft^3

Other Symbology Includes:

Symbol	Definition
AFRSI	Advanced Flexible Reusable Surface Insulation
ARC	Ames Research Center
Bal.	Balance
equiv.	Equivalent
Fus.	Fuselage
Fwd.	Forward
H.L.	Hingeline
IML	Inner Mold Line
Inb'd	Inboard
inc.	Increment
L.E.	Leading-Edge
L.H.	Left-Hand
LRSI	Low Temperature Reusable Surface Insulation
MAC	Mean Aerodynamic Chord, inches
Max.	Maximum
Min.	Minimum
M.L.	Mold Line
Mod.	Modification

NOMENCLATURE (Concluded)

Symbol	Definition
NAAL	North American Aerodynamics Laboratory
No.	Number
O-graph	Oscillograph
OML	Outer Mold Line
OMS	Orbiter Maneuvering System
Outb'd	Outboard
R.H.	Right-Hand
Sta.	Station
SSV	Space Shuttle Vehicle
STS	Space Transportation System
T.E.	Trailing Edge
TEMP	Temperature
Theo.	Theoretical
WP	Waterplane
W_{set}	Weight Set

REMARKS

All objectives were met during Test OA-309. However, due to a malfunctioning tunnel-motor clutch which required extensive repair, there was a 15-week hiatus amid testing. Repairs to the tunnel were completed on August 22, 1983, and testing was resumed the next day. The test was completed on August 24, 1983. Ten runs were made during these two final days. These runs, plus one run made just before the tunnel breakdown, comprised the final kerosene-and-talc boundary-layer flow-visualization segment of Test OA-309.

It should also be noted that there are no still photographs contained in this report for the tufting used with the vortex generators on the tunnel floor.

CONFIGURATIONS INVESTIGATED

The model provided for Test OA-309 was a 0.0405-scale representation of the 140C Space Shuttle Orbiter outer mold line configuration (see Figure 2a). Model installation was accomplished with the sting/support system utilizing the 2.5-inch MK.IX Master Balance Gage, the W-1052 sting, and the 15-inch sting adaptor. The basic model was of the blended-wing/body design utilizing a double-delta wing ($75^{\circ}/45^{\circ}$ L.E.), full-span, dual-panel elevons (unswept hingeline and 6-inch gaps), a centerline vertical tail with rudder-and/or speedbrake-deflection capability, a canopy, a bodyflap, and orbital maneuvering system (OMS) pods mounted on the aft fuselage sidewalls adjacent to the vertical tail.

The starboard side of the model was spray-painted black to facilitate smoke and tuft studies. The port side was initially unpainted and used for Kulite and total-head rake measurements. Transition grit was located on the model nose and all swept surfaces to provide forced boundary-layer transition. Nominal grit-diameter for all surfaces except the fuselage was 0.0076 inch and was 0.0054 inch for the fuselage. The 0.10-inch-thick strip was located 1.0 inch (streamwise) aft of the local leading edge.

For Test OA-309, the following nomenclature was used to designate various model components:

Component	Description
B_{62}	140C Orbiter Body
C_{12}	140C Orbiter Canopy

CONFIGURATIONS INVESTIGATED (Concluded)

Component	Description
E_{55}	140C Orbiter Dual-Panel Elevons
F_{10}	140C Orbiter Bodyflap
M_{16}	140C Orbiter OMS Pod
N_{28}	140C Orbiter OMS Nozzles
W_{127}	140C Orbiter Double-Delta Wing
R_5	140C Orbiter Rudder
V_8	140C Orbiter Centerline Vertical Tail
X_9	Transition Grit

INSTRUMENTATION

Fifteen Statham transducers were calibrated to ±1 psi and used to measure 11 dynamic pressures on a boundary-layer rake and one static pressure on a "bug." Three transducers were available as spares. The transducers were referenced to the tunnel static-pressure ring (P_{12}).

One ±15 psi differential Kulite transducer (XCQH-093) was attached to the end of a probe and used to monitor the airflow behind the vortex generator. The probe Kulite was referenced to atmosphere in the control room. Flat-pack transducers (LQL-080-25) were mounted on various locations on the model, but were not calibrated (see Figure 2c). Oscillograph traces of the measurements from the Kulites located in the region of AFRSI damage are given in the Appendix of this report.

The eleven-tube total-pressure rake was mounted immediately forward of the OMS pod (Figure 2d) and at two locations on the pod (Figures 2e and 2f). The rake was also mounted at two locations on the wing, with the rake face at the elevon hinge line, either 8 inches or 4 inches (model scale) inboard from the wing tip (Figures 2h and 2i, respectively). In addition, the rake was positioned at the location just forward of the OMS pod, with the OMS pod removed and the resulting cavity faired with tunnel wax (Figure 2g).

Velocity profiles for an angle-of-attack of zero degrees and 10 degrees (as measured by the rake) are presented in the Appendix of this report. It should

also be noted that the bottom tube of the rake was 0.2 inches above the model surface and the distance between tube centerlines was also 0.2 inches.

TEST FACILITY DESCRIPTION

The North American Aerodynamics Laboratory (NAAL) 7.75 x 11.00-foot wind tunnel is a continuous-flow, closed-circuit, single-return tunnel capable of speeds up to 200 miles per hour.

The test section is vented to atmospheric pressure and is 7.75 x 11.00 feet wide and 12 feet long. Power is supplied by a 1250-horsepower, nacelle-mounted, synchronous motor driving a 19-foot, seven-blade, laminated-birch propeller. Airspeed is controlled by using a magnetic clutch to vary the degree of coupling between the motor and propeller. Turbulence is minimized by a damping screen and a honeycomb section in the settling chamber upstream from the contraction cone (ratio 7.53 to 1).

Tests may be conducted using a variety of mounting systems: single strut, double strut, sting/strut, reflection-plane, cable-suspension, or two-dimensional wall. Aerodynamic data may be measured by a planar-type external balance system or sting-mounted internal balances. An Astrodata Automatic Data Acquisition System collects, multiplexes, digitizes, and records on magnetic tape 50 channels of force or pressure data, or both. Data are then reduced and plotted using automatic data-processing equipment and an automatic digital plotter.

The NAAL wind tunnel has been operating since June 1943. Calibrations are available over a wide range of test conditions.

TEST PROCEDURES

Smoke, tufts, and oil flow were used to visualize the orbiter flowfields. Kulite pressure transducers were utilized to measure the acoustic environment, and boundary-layer profiles were determined with a total-pressure rake. In addition, four different vortex generators were mounted on the tunnel floor, and vortex characteristics were measured by probing the flowfields behind the vortex generators with a 15-psi Kulite transducer. The vortex generators were studied at angles of 0, 5, 10, and 15 degrees. The vortex-generator tests were used to support Test OS-314, which was conducted in the ARC 9x7-ft wind tunnel during May 1983 in order to evaluate AFRSI characteristics with an impressed vortex.

The test procedure was to pitch the model from -5 degrees angle of attack to 35 degrees in 5-degree pitch-pause increments and take still and motion picture photographs. A continuous-pitch sweep from -5 degrees to 35 degrees was made with the tufts on the model and the resulting flowfields recorded with top and side-view motion-picture cameras. Some still photographs taken during Test OA-309 are presented in the Appendix of this report. Operating conditions for the test were nominally q = 7, 10, 35, 60, and 80 psf. About half of the smoke flow was at a dynamic pressure of 10 psf. Oil flows were conducted at a dynamic pressure of 80 psf. A summary of test conditions for Test OA-309 is shown in Table I. A summary of the runs completed during Test OA-309 is shown in Table II.

Runs 1 through 6 were devoted to smoke-wand studies. .The wand was fed into the tunnel via the hole in the north window of the test section which permitted

access to the complete right side of the model. Still photographs were taken with two Polaroid cameras: one on top of the test section and one in the north window (see Appendix). Motion pictures were taken with a Milliken camera mounted on top of the test section. Film speed was 50 frames per second.

Runs 7 and 8 were tuft-study runs. The right side of the model was tufted from the nose to the aft trailing edge and photographed from the top and side by both a Polaroid (see Appendix) and Milliken cameras.

Also, during Test OA-309, tufting on the tunnel floor was used to observe the effect of the vortex generators mounted on the tunnel floor. A Kulite mounted on the end of a movable, hand-held probe was used to measure fluctuating and static pressures downstream of the vortex generator. It should be noted that four different vortex generators were tested, one at a time, during the course of runs 9 through 32 (see Table II). Figure 2b depicts one of the four vortex generators installed on the floor of the NAAL lowspeed wind tunnel. This configuration is representative of the vortex-generator installations used during Test OA-309.

Kerosene-and-talc flow visualization techniques had just begun on May 9, 1983 when tunnel problems forced the test to end temporarily. Alpha = 15 degrees was the only angle to be completed before this suspension of testing. During this one run (Run 33), a Milliken movie camera was used to show flow-pattern development, and a Polaroid camera was used to photograph areas of interest after the mixture dried.

Repairs to the tunnel were completed on August 22, 1983, and testing was resumed the next day. Kerosene-and-talc flow visualization was performed at angles of attack of -5° through 35° at 5° increments with a sideslip of 0°. In addition, a run with an angle of attack of 15° and with an angle of sideslip of 2° was made, for a total of 10 runs. Each run consisted of spraying the entire surface of the model (except for the base of the model) with a kerosene-and-talc mixture and immediately running the tunnel at 80 psf dynamic pressure until the flow pattern was fully established and drying was well underway. After the tunnel was shut down and the drying of the resultant flow pattern had been completed, photos were taken, with both Polaroid and 4" x 5" film, of the entire model and of specific areas of interest on the model (see Appendix). No movie camera was used to photograph the flow-pattern development during these last 10 runs.

DATA REDUCTION

Pressure data from the boundary-layer rake and the static-pressure bug were recorded by the NAAL data-acquisition system. This information was reduced to coefficient form and into velocity profiles. Local velocity was determined as follows:

$$V_\ell = \frac{V_\ell}{V_o} V_o = \sqrt{C_p}\, V_o$$

where $V_o = \sqrt{\frac{2q_o}{\rho_o}} = \sqrt{\frac{2\times 33.36}{0.002378}} = 167.5 \frac{ft}{sec}$

and $C_p = \frac{q_\ell}{q_o}$

The Cp's obtained from the boundary-layer rake are presented in the Appendix of this report.

The probe's Kulite transducer was recorded on a NAAL oscillograph and on an STSD recording system. The Kulite was also monitored on an oscilloscope.

REFERENCES

1. R.J. Mennell, DMS-DR-2361, Vol. 2 of 2, "Results of a Landing Gear Loads Test Using a 0.0405-Scale Model (16-O) of the Space Shuttle Orbiter in the Rockwell International NAAL Wind Tunnel (OA-163B)" (July 1977)

Table I

TEST : OA-309 DATE : 8-24-84

TEST CONDITIONS

MACH NUMBER	Total Pressure (pounds/sq. ft.)	Dynamic Pressure (pounds/sq. ft.)	
0.075	2123	7	
0.082	2126	10	
0.153	2151	35	
0.200	2176	60	
0.231	2196	80	

BALANCE UTILIZED: NA

	CAPACITY:	ACCURACY:	COEFFICIENT TOLERANCE:
NF			
SF			
AF			
PM			
RM			
YM			

COMMENTS:

Table II. Run Summary for Test OA-309

q	W_{set}
7	0.255
10	0.375
35	1.293
60	2.217
90	2.948

SCHED	α VARIABLE SCHEDULE
A	−5° → +35° @ 5° inc
B	−5° → +35° @ constant sweep
C	
D	
E	
F	
G	
H	

SCHED	ψ VARIABLE SCHEDULE
A	
B	
C	
D	
E	
F	
G	
H	

NAAL 838	PAGE 1 OF 2
MODEL SSV 16-0	SCALE 0.0405
STRUT NONE	STRUT SPACING
STING W-105.2	BALANCE 2.5" MK IX

Master Bal Gage

DATE	RUN	q	TIME	Variable Schedule α (STRUT OR STING)	Variable Schedule ψ (TURNTABLE)	Variable Schedule φ (MODEL)	BASIC CONFIGURATION	SMOKE	MODEL TUFTS	VORTEX GEN TUFTS	VORTEX GEN	KULITE POSITION	B.L. RAKE	KEROSENE & TALC	INSTRUMENT LOG NO.	USE STATIC TARE	PICTURES	REMARKS
4/26/83	1	10	1300	A	0	0	SSV 16-0	✓										
✓	2	10	1345	A	0	0		✓										
✓	3	10	1430	A	0	0		✓										
✓	4	7	1500	A	0	0		✓										
4/27/83	5	7	1030	A	0	0		✓										
	6	7	1300	A	0	0		✓									✓	
4/28/83	7	60	1300	A	0	0			✓								✓	
	8	60	1430	B	0	0			✓								✓	
4/29/83	9	60/35	1030	A	0	0					4/0°	1					✓	
	10	60/35	1425	A	0	0					4/5°	2					✓	
	11	60/35	1530	A	0	0					4/10°	3					✓	
5/2/83	12	60/35	1030	A	0	0					4/10°	3						Repeat Run 11
	13	60	1300	A	0	0						2						Repeat Run 10
	14	60/35	1955	A	0	0					4/0°	1						Repeat Run 9
5/3/83	15	35	1315	A	0	0					7/0°	4					✓	
	16	35	1415	A	0	0						4						Tried to calibrate Ograph
	17	35	1453	A	0	0						4						"
5/4/83	19	35	0915	A	0	0						6						
	20	35	1456	A	0	0					7/5°		✓				✓	
	21	35	1520	A	0	0					7/10°							
5/5/83	22	35	0810	A	0	0					7/15°		✓				✓	
	23	35	0920	A	0	0					8/0°		✓				✓	
	24	35	0935	A	0	0	(LH OMS pod off)						✓				✓	
	25	35	1100	A	0	0					1/10°							

Table II. Run Summary for Test OA-309 (concluded)

q	W_{set}
7	0.255
10	0.375
35	1.293
60	2.217
80	2.948

SCHED	α VARIABLE SCHEDULE
A	-5° → +35° @ 5° inc.
B	-5° → +35° @ constant sweeps
C	
D	
E	
F	
G	
H	

SCHED	ψ VARIABLE SCHEDULE
A	
B	
C	
D	
E	
F	
G	
H	

NAAL 838	PAGE 2 OF 2
MODEL SSV 16-0	SCALE 0.0405
STRUT NONE	STRUT SPACING
STING W-1052	BALANCE 2.5" MK IX Modern Bal. Gage

DATE	RUN	q	TIME	α (STRUT PITCH)	ψ (TURN TABLE)	φ (MODEL)	BASIC CONFIGURATION	SMOKE	MODEL TUFTS	VORTEX GEN TUFTS	VORTEX GEN	KULITE POSITION	DL RAKE	KEROSENE & TARE	INSTRUMENT LOG NO.	USE STATIC TARE	PICTURES	REMARKS
5/5/83	26	35	1355	A	0	0	SSV 16-0						✓				✓	
	27	35	1515	A	0	0	↓				8/3°		✓				✓	
5/6/83	28	35	1045	A	0	0					/15°	D,F,G						
	29	35	1330	A	0	0				✓	10/0°	H,I						
	30	35	1512	A	0	0				✓	10/5°	E,J						
5/[illegible]/83	31	35	0905	A	0	0				✓	10/10°	A,B						
	32	35	1000	A	0	0				✓	10/15°	C,D						
	33	80	1445	15	0	0								✓			✓	To be repeated
8/23/83	34	80	0900	30	0	0								✓			✓	
	35	80	1015	15	0	0								✓			✓	
	36	80	1242	35	0	0								✓			✓	Repeat of 33 for better close-up photos
	37	80	1351	25	0	0								✓			✓	
	38	80	1506	20	0	0								✓			✓	
8/24/83	39	80	0845	15	2	0								✓			✓	
	40	80	1130	10	0	0								✓			✓	
	41	80	1227	6	0	0								✓			✓	
	42	80	1325	0	0	0								✓			✓	
	43	80	1420	-5	0	0	↓							✓			✓	

Table III. MODEL DIMENSIONAL DATA

MODEL COMPONENT : BODY - B_{62}

GENERAL DESCRIPTION : Configuration 140C orbiter fuselage, MCR 200-R4. Similar to 140A/B fuselage except aft body revised and improved midbody-wing-boot fairing, X_0 = 940 to X_0 = 1040.

MODEL SCALE: 0.0405

DRAWING NUMBER : VL70-000140C, -000202C, -000205A
VL70-000200B, -000203

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (IML: Fwd Sta. X_0=238), In.	1290.3	52.257
Length (OML: Fwd Sta. X_0 =235), In.	1293.3	52.379
Max Width (@ X_0 = 1528.3), In.	264.0	10.692
Max Depth (@ X_0 = 1464), In.	250.0	10.125
Fineness Ratio	4.899	4.899
Area - Ft^2		
Max. Cross-Sectional	340.885	0.559
Planform		
Wetted		
Base		

TABLE III. MODEL DIMENSIONAL DATA (Continued)

MODEL COMPONENT: CANOPY - C_{12}

GENERAL DESCRIPTION: Configuration 140C orbiter canopy, vehicle cabin No. 31 updated to MCR 200-R4. Used with fuselage B_{62}.

MODEL SCALE: 0.0405

DRAWING NUMBER: VL70-000140C, -000202B, -000204

DIMENSIONS:

	FULL SCALE	MODEL SCALE
Length (X_o = 434.643 to 578), In.	143.357	5.806
Max Width (@ X_o = 513.127), In.	152.412	6.173
Max Depth (Z_o = 501 to 449.39), In.	51.61	2.090

TABLE III. MODEL DIMENSIONAL DATA (Continued)

MODEL COMPONENT: ELEVON - E55

GENERAL DESCRIPTION: Configuration 140C dual panel elevon. Elevon hinge-line at X_o = 1387. Elevon split line at Y_o = 281 to 312.5. Upper wing/elevon gap sealed by flipper doors.

MODEL SCALE: 0.0405

DRAWING NUMBER: VL70-000140C, -006089, -000200B, -006092

DIMENSIONS:	FULL SCALE	MODEL SCALE
Area, Ft^2	210.00	0.344
Span (equivalent), In.	349.20	14.143
Inb'd equivalent chord, In.	118.00	4.779
Outb'd equivalent chord, In.	55.19	2.235
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.210	0.210
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge	0.0	0.0
Trailing Edge	- 10.056	- 10.056
Hingeline	0.0	0.0
Area Moment (Product of Area & $\bar{c}$), Ft^3	1587.25	0.1054
Mean Aerodynamic Chord, In.	90.70	3.673

TABLE III. MODEL DIMENSIONAL DATA (Continued)

MODEL COMPONENT: BODY FLAP - F_{10}

GENERAL DESCRIPTION: Configuration 140C body flap. Hingeline located at $X_o = 1532$, $Z_o = 287$.

MODEL SCALE: 0.0405

DRAWING NUMBER: VL70-000140C, -355114

DIMENSIONS:	FULL SCALE	MODEL SCALE
Length (X_o = 1525 to X_o = 1613), In.	87.50	3.544
Max Width (@ L.E., X_o = 1525.5), In.	256.00	10.368
Max Depth (X_o = 1532), In.	19.798	0.802
Area		
Max. Cross-Sectional (@ H.L.)	35.196	0.058
Planform	135.00	0.221
Wetted		
Base (X_o = 1613)	4.89	0.008

TABLE III. MODEL DIMENSIONAL DATA (Continued)

MODEL COMPONENT: OMS POD - M_{16}

GENERAL DESCRIPTION: Configuration 140C orbiter OMS pod - short pod.

MODEL SCALE: 0.0405

DRAWING NUMBER: VL70-008401, -008410

DIMENSIONS:	FULL SCALE	MODEL SCALE
Length (OMS Fwd. sta. X_o = 1310.5), in.	258.50	10.469
Max Width (@ X_o = 1511), in.	136.8	5.540
Max Depth (@ X_o = 1511), in.	74.70	3.025
Area, Ft^2		
Max. Cross-Sectional	58.864	0.0966

TABLE III. MODEL DIMENSIONAL DATA (Continued)

MODEL COMPONENT: OMS NOZZLES - N_{28}

GENERAL DESCRIPTION: Configuration 140C - orbiter OMS nozzles.

MODEL SCALE: 0.0405

DRAWING NUMBER: VL70-000140A (Location), SS-A00106, Release 5 (Contour)

DIMENSIONS:	FULL SCALE	MODEL SCALE
Gimbal Point (Station), in.		
Left Nozzles		
X_o	1518.00	61.479
Y_o	- 88.0	- 3.564
Z_o	492.0	19.926
Right Nozzles		
X_o	1518.00	61.479
Y_o	88.00	3.564
Z_o	492.00	19.926
Null Position - Deg.		
Left Nozzles		
Pitch	15°49'	15°49'
Yaw	12°17'	12°17'
Right Nozzles		
Pitch	15°49'	15°49'
Yaw	12°17'	12°17'

TABLE III. MODEL DIMENSIONAL DATA (Continued)

MODEL COMPONENT: WING - W_{127}

GENERAL DESCRIPTION: Configuration 140C orbiter wing, MCR 200-R4, similar to 140A/B wing W_{116} but with refinements: Improved wing-boot-midbody fairing (X_o = 940 to X_o = 1040); elevon split line relocated from Y_o = 281 to Y_o = 312.5. MODEL SCALE: 0.0405 DWG.NO.: VL70-000140C, -200B

DIMENSIONS:	FULL SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo.), ft^2		
Planform	2690.00	4.412
Span (Theo.), in.	936.68	37.936
Aspect Ratio	2.265	2.265
Rate of Taper	1.177	1.177
Taper Ratio	0.200	0.200
Dihedral Angle, degrees	3.500	3.500
Incidence Angle, degrees	0.500	0.500
Aerodynamic Twist, degrees		
Sweep Back Angles, degrees		
Leading Edge	45.000	45.000
Trailing Edge	- 10.056	- 10.056
0.25 Element Line	35.209	35.209
Chords:		
Root (Theo.) B.P.O.O.	689.24	27.914
Tip, (Theo.) B.P.	137.85	5.583
MAC	474.81	19.230
X_o of .25 MAC	1136.83	46.042
Z_o of .25 MAC	290.58	11.769
Y_o of .25 MAC	182.13	7.736
EXPOSED DATA		
Area (Theo.), ft^2	1751.50	2.873
Span, (Theo.), in. BP108	720.68	29.188
Aspect Ratio	2.059	2.059
Taper Ratio	0.245	0.245
Chords		
Root BP108	562.09	22.765
Tip 1.00 b/2	137.85	5.583
MAC	392.83	15.910
X_o of .25 MAC	1185.98	48.032
Z_o of .25 MAC	294.30	11.919
Y_o of .25 MAC	251.77	10.197
Airfoil Section (Rockwell Mod NASA) XXXX-64		
Root b/2 =	0.113	0.113
Tip b/2 =	0.120	0.120
Data for (1) of (2) Sides		
Leading Edge Cuff		
Planform Area, ft^2	113.18	0.186
Leading Edge Intersects Fus M.L. @ Sta	500.00	20.250
Leading Edge Intersects Wing @ Sta	1024.00	41.472

TABLE III. MODEL DIMENSIONAL DATA (Continued)

MODEL COMPONENT: RUDDER - R_5

GENERAL DESCRIPTION: Configuration 140C orbiter rudder (identical to configuration 140A/B rudder).

MODEL SCALE: 0.405

DRAWING NUMBER: VL70-000146B, -000095

DIMENSIONS:	FULL SCALE	MODEL SCALE
Area, Ft^2	100.15	0.1643
Span (equivalent), In.	201.00	8.141
Inb'd equivalent chord, In.	91.585	3.709
Outb'd equivalent chord, In.	50.833	2.059
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.400	0.400
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge	34.83	34.83
Trailing Edge	26.25	26.25
Hingeline	34.83	34.83
Area Moment(Product of Area & $\bar{c}$), Ft3	610.92	0.0406
Mean Aerodynamic Chord, In.	73.2	2.965

TABLE III. MODEL DIMENSIONAL DATA (Continued)

MODEL COMPONENT: VERTICAL - V_8

GENERAL DESCRIPTION: Configuration 140C orbiter vertical tail (identical to configuration 140A/B vertical tail).

MODEL SCALE: 0.0405

DRAWING NUMBER: VL70-000140C, 70-000146B

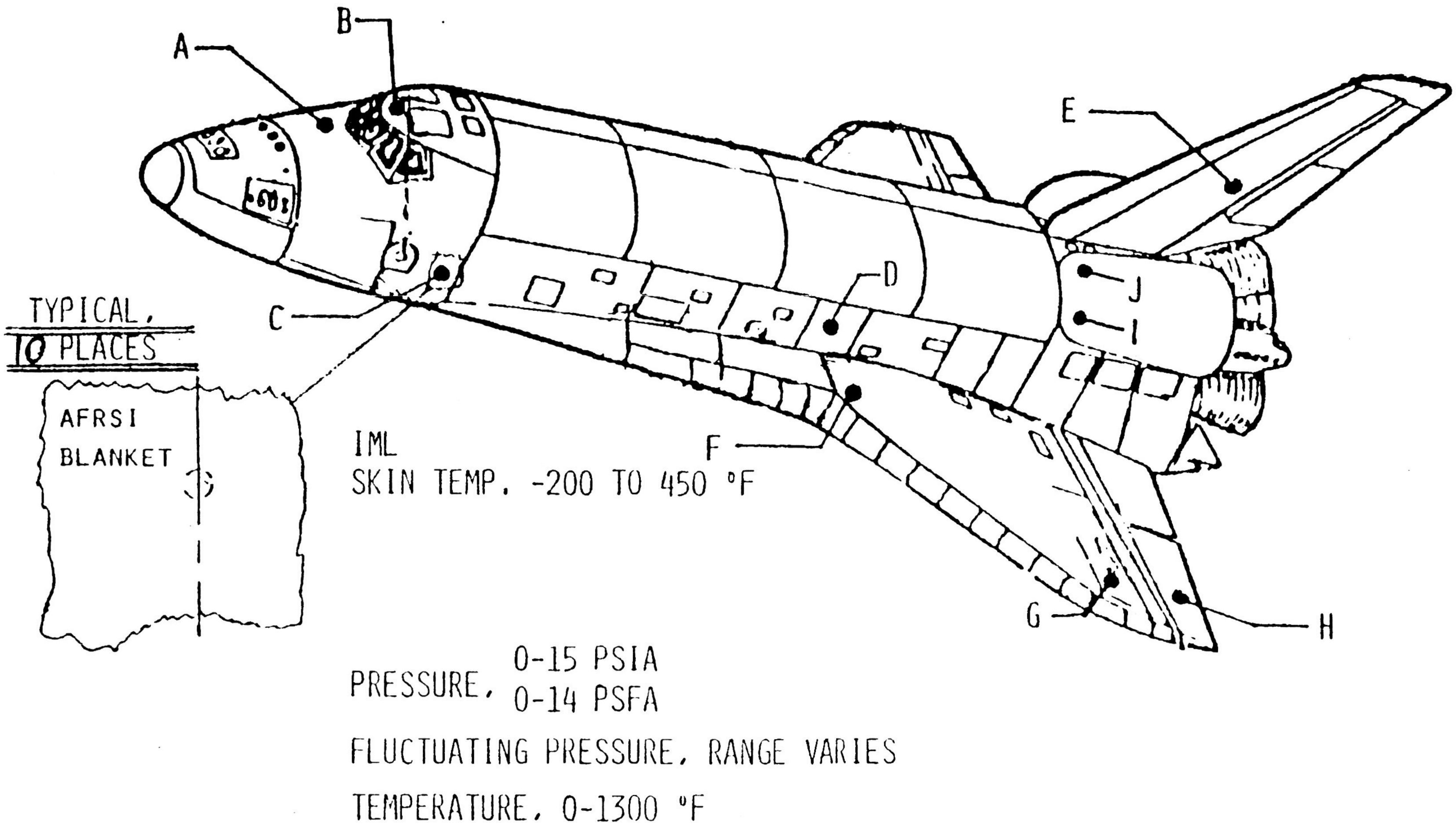
DIMENSIONS:	FULL SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo.), ft^2		
Planform	413.253	0.678
Span (Theo.), in.	315.72	12.787
Aspect Ratio	1.675	1.675
Rate of Taper	0.507	0.507
Taper Ratio	0.404	0.404
Sweep Back Angles, degrees		
Leading Edge	45.00	45.00
Trailing Edge	26.25	26.25
0.25 Element Line	41.13	41.13
Chords:		
Root (Theo.) WP	268.50	10.874
Tip (Theo.) WP	108.47	4.393
MAC	199.81	8.092
X_o of .25 MAC	1463.35	59.266
Z_o of .25 MAC	635.52	25.739
Y_o of .25 MAC	0.00	0.00
Airfoil Section		
Leading Wedge Angle, deg.	10.00	10.00
Trailing Wedge Angle, deg.	14.92	14.92
Leading Edge Radius	2.00	0.0810
Void Area	13.17	0.022
Blanketed Area	0.0	0.0

TABLE III. MODEL DIMENSIONAL DATA (Concluded)

MODEL COMPONENT: TRANSITION GRIT - X_9

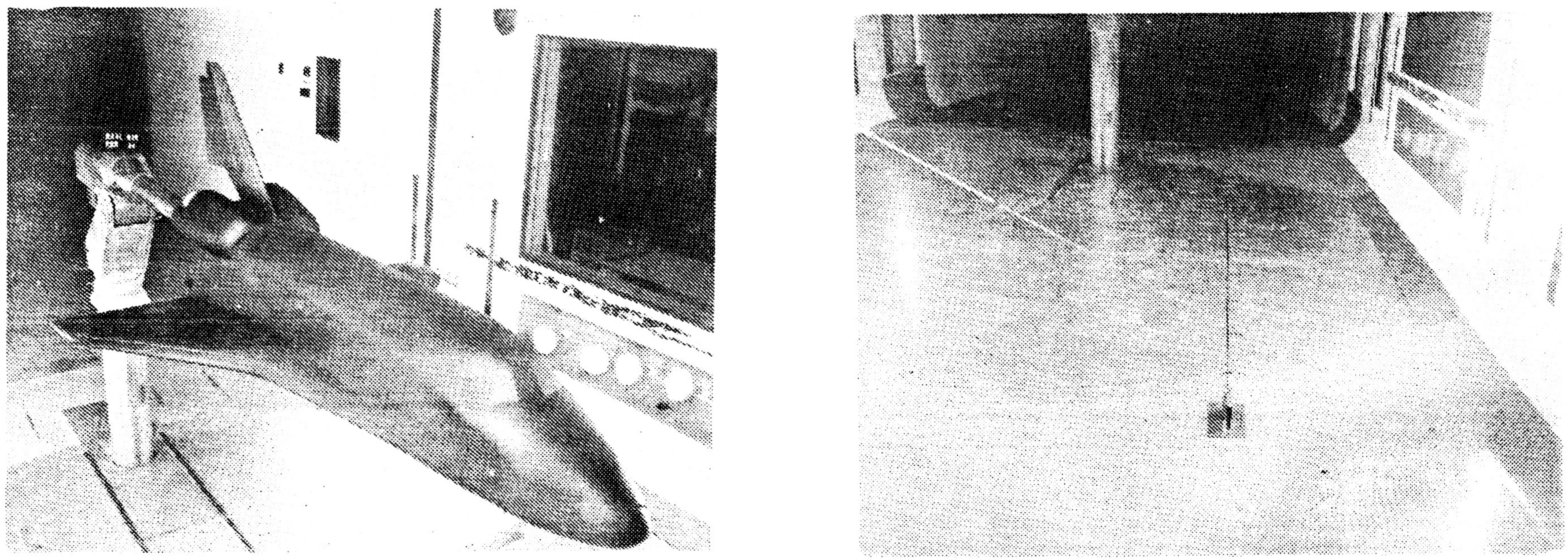
GENERAL DESCRIPTION: Grit located on model nose and all swept surfaces to provide forced boundary layer transition.

NOMINAL GRIT DIAMETER - IN.	
Fuselage	0.0054
All surfaces except fuselage	0.0076
STRIP THICKNESS - IN.	0.10
LOCATION:	
Inches aft of local leading edge (streamwise)	1.00



a. CRITICAL AREAS OF AFRSI APPLICATION (Configuration sketch)

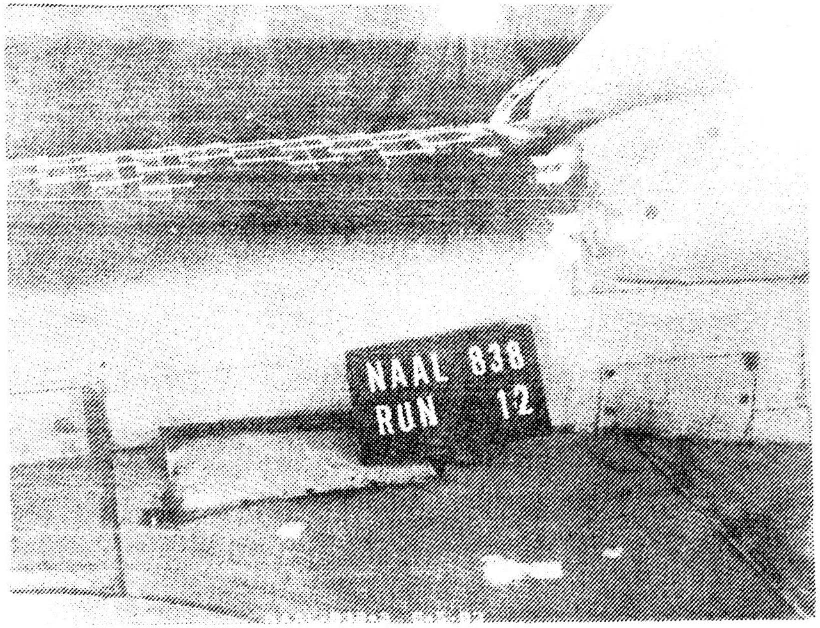
Figure 1. Model Figures



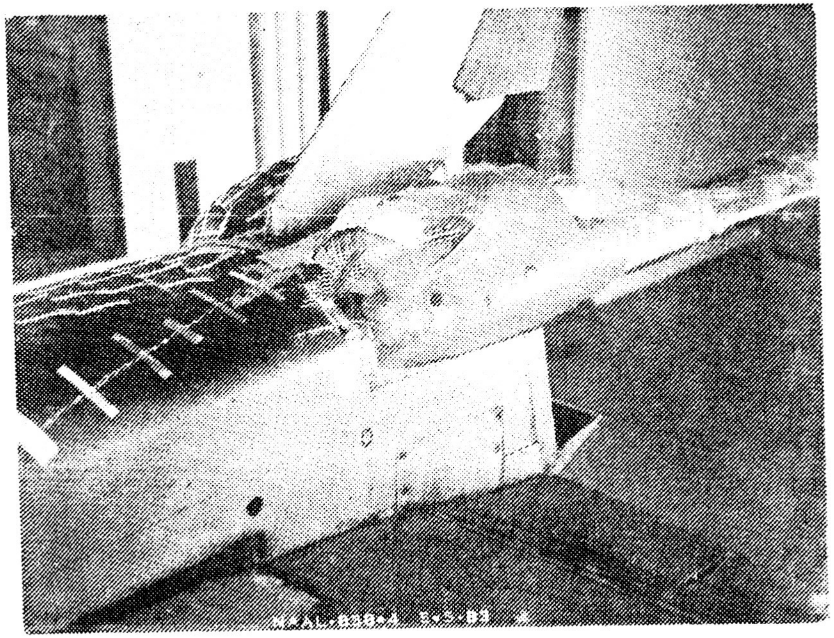
a. Space Shuttle Orbiter Model 16-0 installed in the NAAL Lowspeed Wind Tunnel prior to Run 34.

b. Vortex Generator installed on the floor of the NAAL Lowspeed Wind Tunnel.

Figure 2. Model Photographs

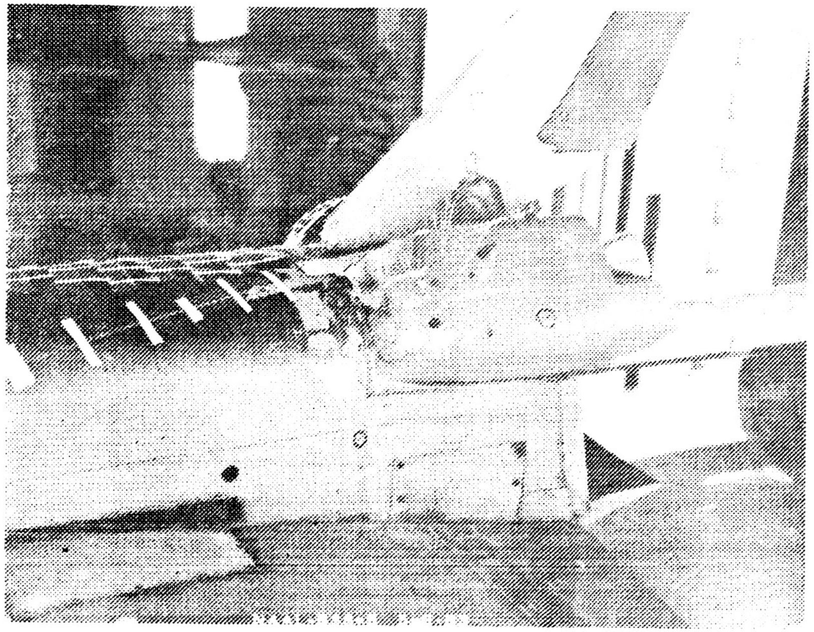


c. Two flat pack Kulite transducers mounted just forward of the OMS pod on the Space Shuttle Orbiter Model 16-O installed in the NAAL Low-speed Wind Tunnel (Run 12).

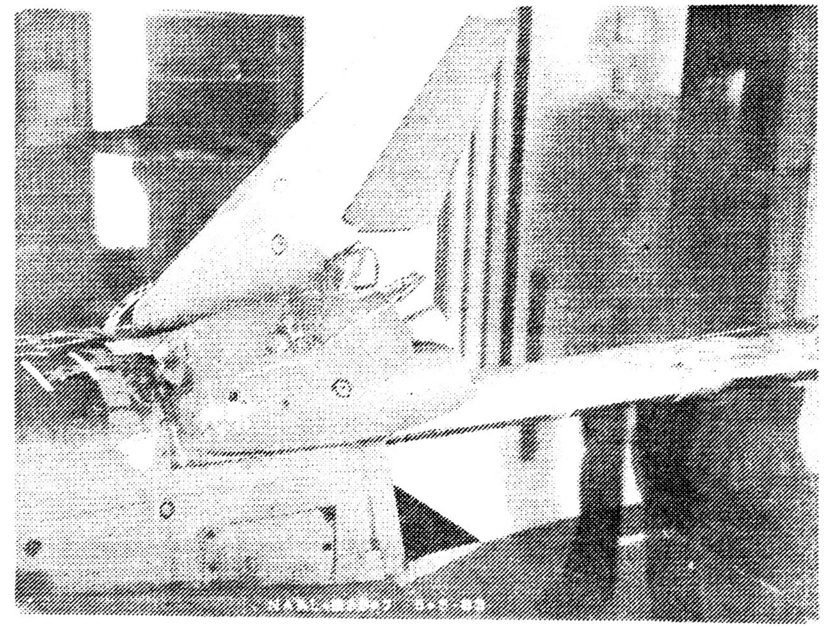


d. Eleven-tube total pressure rake mounted immediately forward of the OMS pod on the Space Shuttle Orbiter Model 16-O installed in the NAAL Lowspeed Wind Tunnel (Run 20).

Figure 2. Continued.

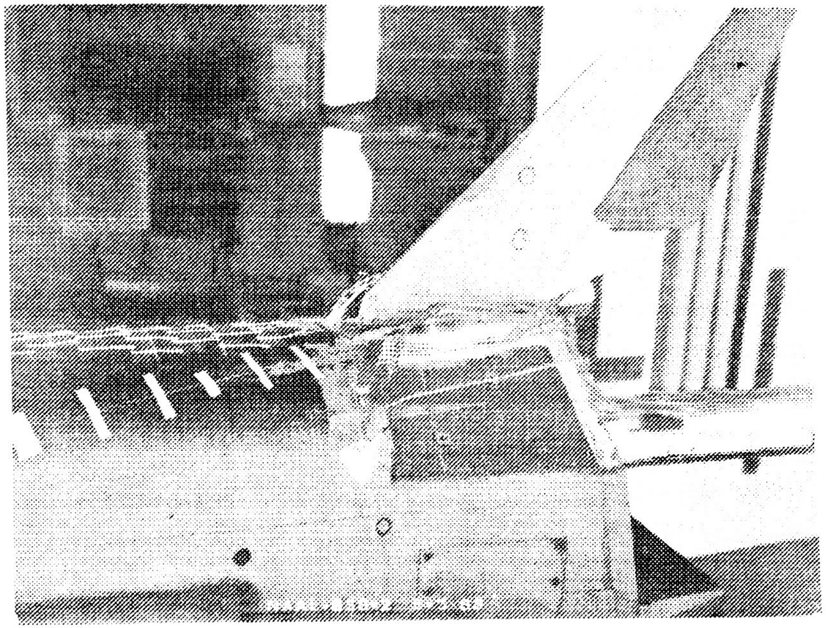


e. Eleven-tube total pressure rake mounted forward on the OMS pod of the Space Shuttle Orbiter Model 16-O installed in the NAAL Lowspeed Wind Tunnel (Run 22).



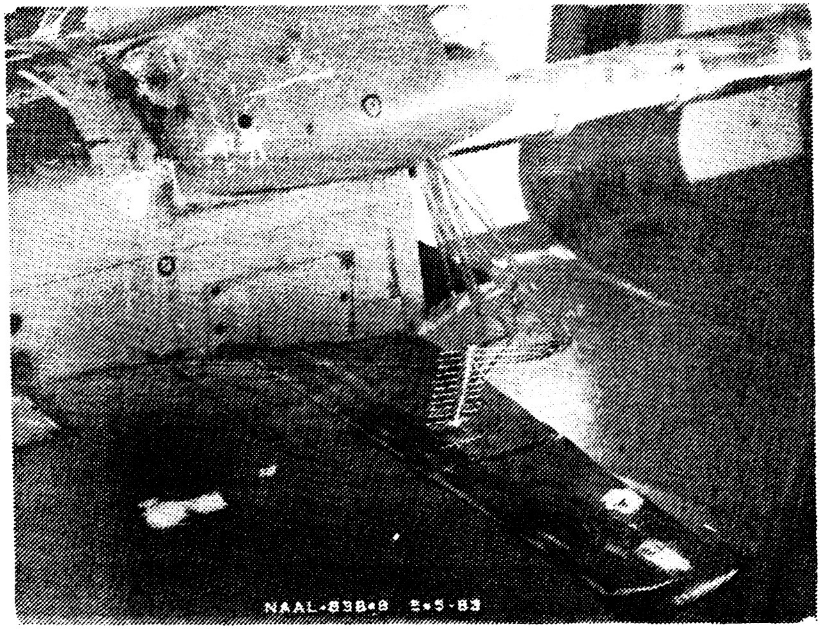
f. Eleven-tube total pressure rake mounted midway on the OMS pod of the Space Shuttle Orbiter Model 16-O installed in the NAAL Lowspeed Wind Tunnel (Run 23).

Figure 2. Continued.

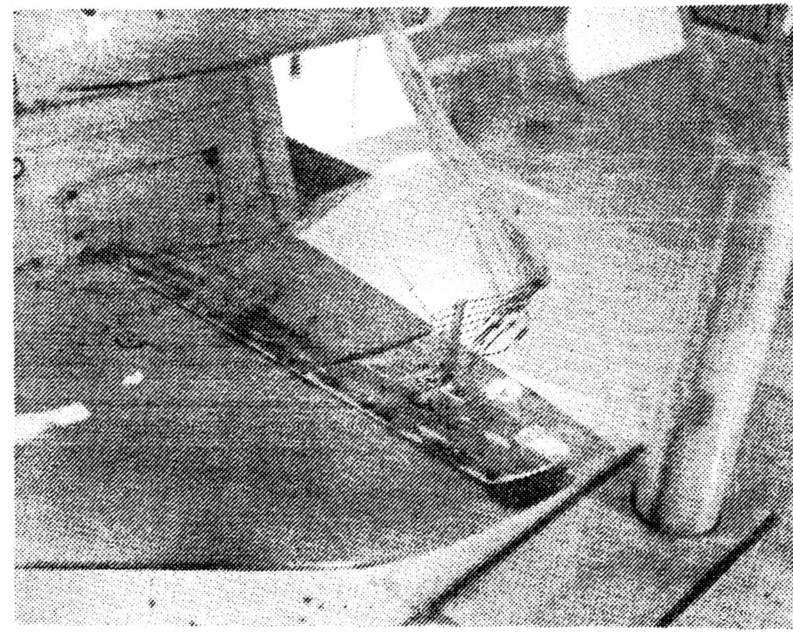


g. Eleven-tube total pressure rake mounted forward of the OMS pod with the OMS pod removed from the Space Shuttle Orbiter Model 16-0 installed in the NAAL Lowspeed Wind Tunnel (Run 24).

Figure 2. Continued.



h. Eleven-tube total pressure rake mounted with the rake face at the elevon hinge line 8 inches inboard from the Space Shuttle Orbiter Model 16-0 wing tip in the NAAL Lowspeed Wind Tunnel (Run 26).

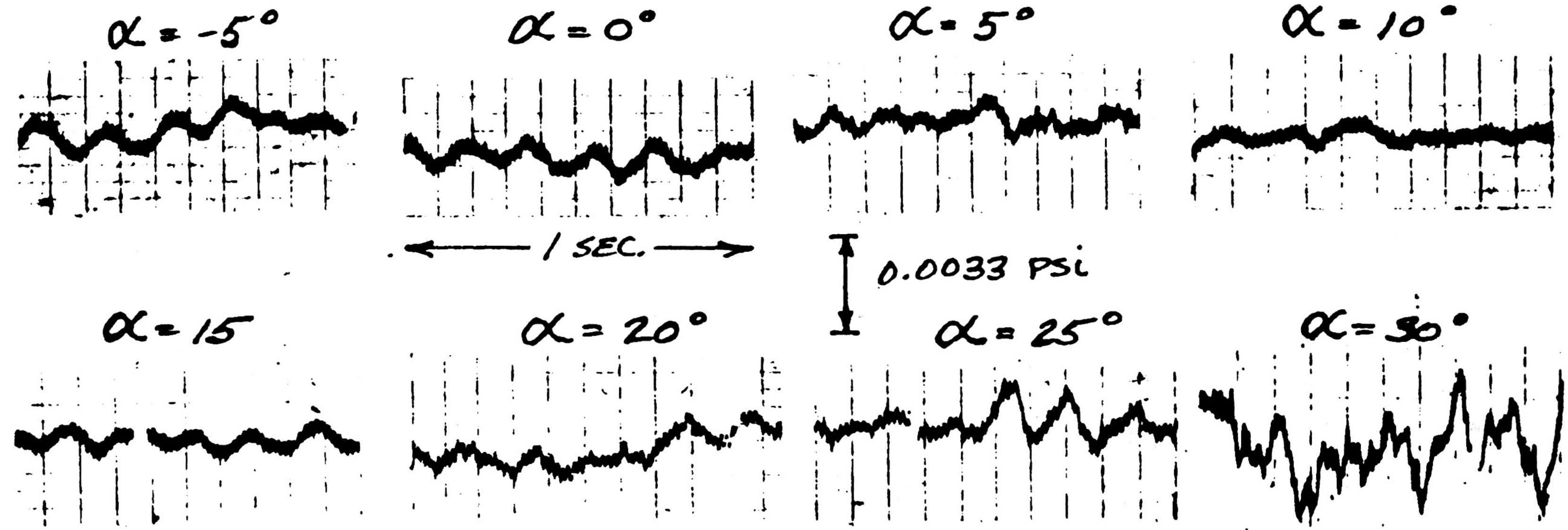


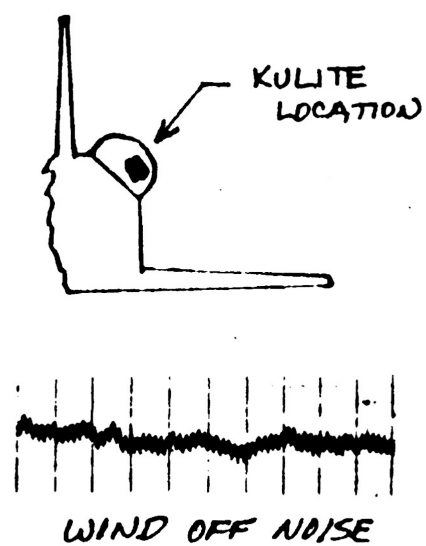
i. Eleven-tube total pressure rake mounted with the rake face at the elevon hinge line 4 inches inboard from the Space Shuttle Orbiter Model 16-0 wing tip in the NAAL Lowspeed Wind Tunnel (Run 27).

Figure 2. Concluded

APPENDIX

OSCILLOGRAPH TRACES OF KULITES LOCATED ON THE OMS POD OF MODEL 16-0





- VORTEX STRENGTH VERY SMALL (NEGLIGIBLE)
- UNSTEADY AERO PRESENT AT ALL α'S
- BEGINING OF STALL $\alpha = 25°$
- STALLED AT $\alpha = 30°$

Figure 3a

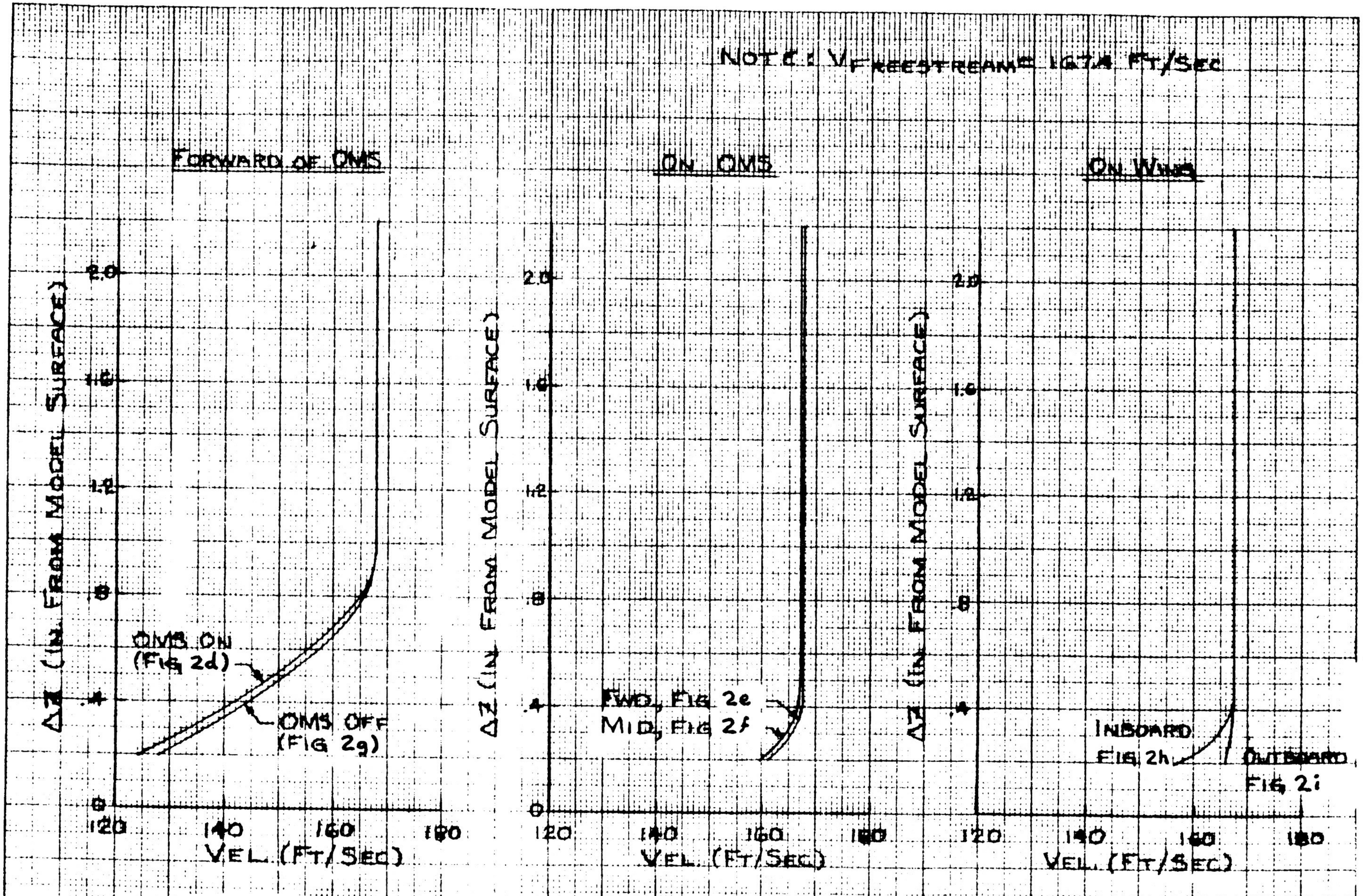


Fig. 4a BOUNDARY LAYER PROFILES, $\alpha = 0°$

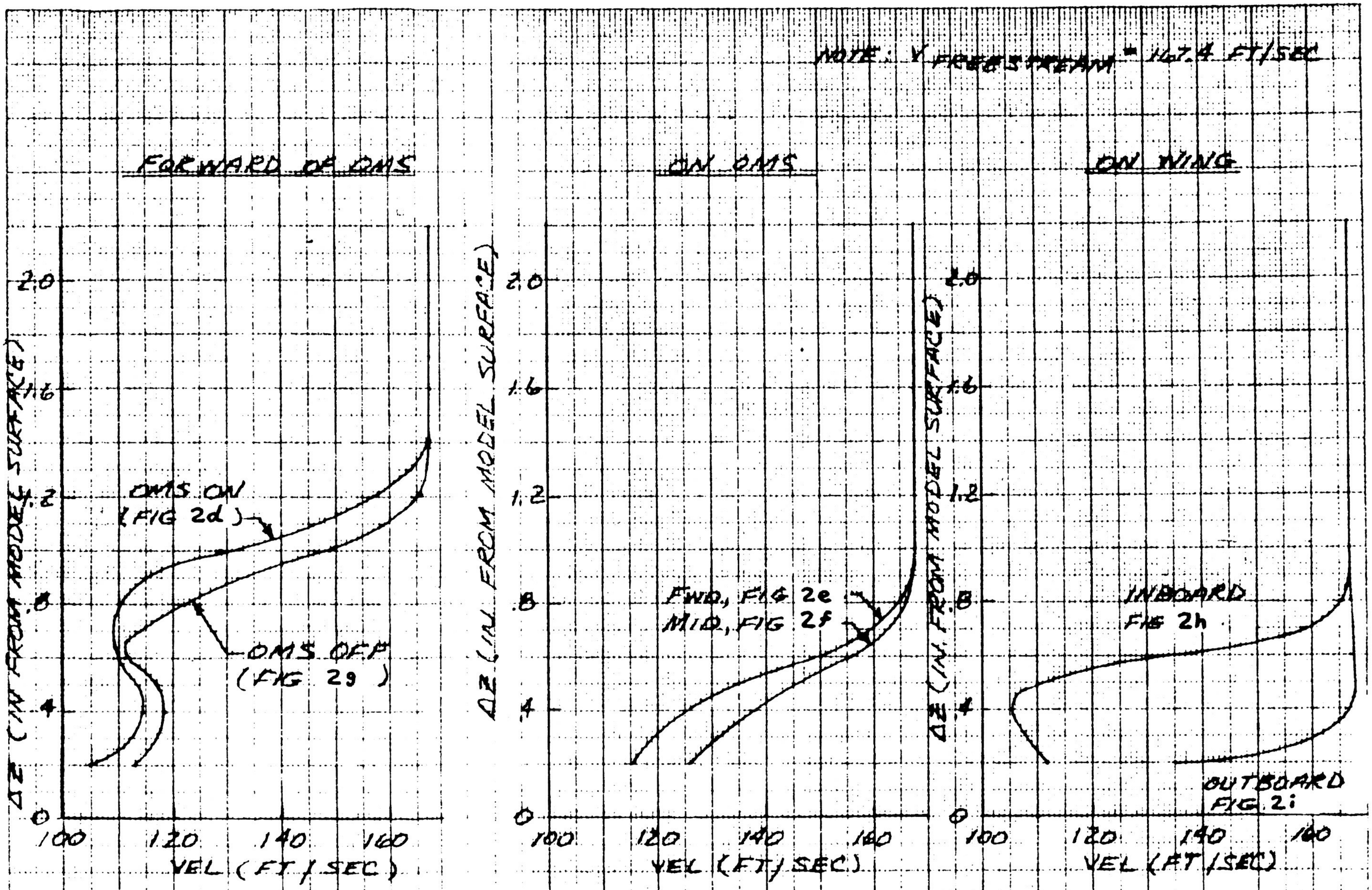


Fig. 4b BOUNDARY LAYER PROFILES, $\alpha = 10°$

NAAL RUN CONFIGURATION BETA RD

83A 20 SPACE SHUTTLE RAKE PRESSURES AHEAD OF OMS (OMS ON) 1

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P 5	P 6	P 7	P 8	P 9	P10	P11	P12
1	-4.99	0.7517	0.9280	1.0021	1.0066	1.0083	1.0083	1.0087	1.0088
2	-4.99	0.7513	0.9273	1.0017	1.0069	1.0087	1.0087	1.0094	1.0091
3	-4.99	0.7451	0.9243	0.9996	1.0062	1.0080	1.0079	1.0087	1.0088
4	0.00	0.5430	0.7121	0.8577	0.9710	1.0035	1.0065	1.0068	1.0069
5	0.00	0.5496	0.7178	0.8613	0.9717	1.0024	1.0057	1.0061	1.0058
6	0.00	0.5393	0.7163	0.8606	0.9735	1.0027	1.0054	1.0057	1.0058
7	4.97	0.4100	0.5798	0.6965	0.8014	0.9038	0.9820	1.0054	1.0073
8	4.97	0.4148	0.5896	0.7005	0.8021	0.9057	0.9813	1.0028	1.0040
9	4.97	0.4118	0.5854	0.6980	0.8018	0.9031	0.9791	1.0014	1.0025
10	9.95	0.3928	0.4595	0.4285	0.4289	0.5980	0.8711	0.9966	1.0022
11	9.95	0.3932	0.4632	0.4303	0.4322	0.6085	0.8740	1.0024	1.0069
12	9.95	0.3975	0.4666	0.4354	0.4307	0.5984	0.8726	1.0039	1.0095
13	14.98	0.4477	0.6624	0.6765	0.6442	0.6070	0.5604	0.5833	0.7472
14	14.98	0.4536	0.6665	0.6790	0.6449	0.6096	0.5626	0.5895	0.7564
15	14.98	0.4510	0.6669	0.6790	0.6486	0.6134	0.5667	0.5903	0.7593
16	19.95	0.4236	0.7837	0.8715	0.8620	0.8387	0.8091	0.7814	0.7479
17	19.95	0.4320	0.7920	0.8781	0.8649	0.8409	0.8145	0.7858	0.7483
18	19.95	0.4335	0.7954	0.8821	0.8708	0.8476	0.8197	0.7902	0.7553
19	24.96	0.3400	0.6556	0.8322	0.9133	0.9379	0.9324	0.9086	0.8833
20	24.96	0.3136	0.6254	0.8159	0.9082	0.9364	0.9302	0.9104	0.8856
21	24.96	0.3297	0.6495	0.8333	0.9159	0.9447	0.9408	0.9214	0.8936
22	29.95	0.2678	0.4191	0.5815	0.7199	0.8061	0.8638	0.8976	0.9312
23	29.96	0.2733	0.4255	0.5833	0.7202	0.8094	0.8642	0.9013	0.9323
24	29.95	0.2718	0.4108	0.5633	0.7008	0.7963	0.8583	0.9016	0.9308

NAAL	RUN	CONFIGURATION	BETA
838	20	SPACE SHUTTLE RAKE PRESSURES AHEAD OF OMS (OMS ON)	

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P13	P14	P15	P16 Static Pressure Near Rake
1	-4.99	1.0089	1.0086	1.0097	0.2206
2	-4.99	1.0096	1.0090	1.0101	0.2213
3	-4.99	1.0089	1.0082	1.0094	0.2209
4	0.00	1.0071	1.0060	1.0076	0.1993
5	0.00	1.0060	1.0052	1.0068	0.1993
6	0.00	1.0060	1.0052	1.0068	0.1990
7	4.97	1.0071	1.0056	1.0073	0.1579
8	4.97	1.0038	1.0026	1.0054	0.1579
9	4.97	1.0024	1.0011	1.0036	0.1572
10	9.95	1.0020	1.0003	1.0050	0.1120
11	9.95	1.0067	1.0052	1.0097	0.1120
12	9.95	1.0093	1.0075	1.0119	0.1120
13	14.98	0.9336	0.9871	0.9993	0.0825
14	14.98	0.9362	0.9901	1.0036	0.0821
15	14.98	0.9409	0.9920	1.0047	0.0828
16	19.95	0.7691	0.8477	0.9415	0.0828
17	19.95	0.7728	0.8462	0.9430	0.0835
18	19.95	0.7717	0.8500	0.9473	0.0818
19	24.96	0.8652	0.8824	0.9321	0.0689
20	24.96	0.8692	0.8836	0.9339	0.0707
21	24.96	0.8801	0.9010	0.9484	0.0693
22	29.95	0.9547	0.9731	0.9891	-0.0336
23	29.96	0.9576	0.9739	0.9906	-0.0409
24	29.95	0.9584	0.9769	0.9910	-0.0322

NAAL RUN CONFIGURATION BETA

838 20 SPACE SHUTTLE RAKE PRESSURES AHEAD OF OMS (OMS ON) 8

VELOCITY PROFILE - FEET PER SECOND

PT	ALPHA	V 5	V 6	V 7	V 8	V 9	V10	V11	V12	V13	V14	V15
1	-4.99	145.23	161.36	167.68	168.05	168.20	168.20	168.23	168.24	168.25	168.22	168.31
2	-4.99	145.19	161.30	167.65	168.08	168.23	168.23	168.29	168.27	168.31	168.25	168.34
3	-4.99	144.59	161.03	167.46	168.02	168.17	168.17	168.23	168.24	168.25	168.19	168.28
4	0.00	123.43	141.35	155.13	165.05	167.79	168.04	168.07	168.08	168.10	168.00	168.13
5	0.00	124.18	141.91	155.46	165.12	167.70	167.98	168.01	167.99	168.00	167.94	168.07
6	0.00	123.01	141.76	155.39	165.27	167.73	167.95	157.98	167.99	168.00	167.94	168.07
7	4.97	107.26	127.54	139.79	149.95	159.25	165.99	167.95	168.11	168.10	167.97	168.16
8	4.97	107.88	128.62	140.19	150.02	159.41	165.93	167.74	167.84	167.82	167.72	167.95
9	4.97	107.50	128.16	139.94	149.98	159.18	165.74	167.62	167.71	167.70	167.59	167.80
10	9.95	104.98	113.54	109.65	109.69	129.53	156.34	167.22	167.68	167.67	167.53	167.92
11	9.95	105.03	114.01	109.88	110.12	130.66	156.60	167.71	168.08	168.07	167.94	168.31
12	9.95	105.61	114.42	110.53	109.93	129.57	156.47	167.83	168.30	168.28	168.13	168.49
13	14.98	112.08	136.32	137.77	134.44	130.50	125.40	127.93	144.79	161.85	166.42	167.44
14	14.98	112.82	136.75	138.03	134.52	130.79	125.64	128.61	145.68	162.07	166.67	167.80
15	14.98	112.50	136.79	138.03	134.90	131.19	126.09	128.69	145.96	162.48	166.83	167.89
16	19.95	109.02	148.29	156.37	155.51	153.40	150.67	148.07	144.86	146.90	154.22	162.53
17	19.95	110.09	149.07	156.96	155.78	153.60	151.17	148.48	144.90	147.25	154.08	162.65
18	19.95	110.28	149.39	157.32	156.30	154.22	151.65	148.90	145.57	147.14	154.42	163.03
19	24.96	97.67	135.62	152.81	160.08	162.22	161.74	159.66	157.43	155.81	157.35	161.72
20	24.96	93.81	132.47	151.30	159.63	162.09	161.55	159.82	157.63	156.17	157.45	161.87
21	24.96	96.19	135.00	152.91	160.31	162.80	162.47	160.78	158.34	157.14	158.99	163.12
22	29.95	86.68	108.44	127.73	142.12	150.38	155.68	158.70	161.63	163.67	165.23	166.59
23	29.96	87.57	109.27	127.93	142.15	150.70	155.71	159.02	161.73	163.92	165.30	166.71
24	29.95	87.33	107.36	125.71	140.22	149.47	155.19	159.05	161.60	163.98	165.55	166.74

NAAL	RUN	CONFIGURATION	BETA
338	22	SPACE SHUTTLE RAKE PRESSURES ON FORWARD PART OF OMS (OMS ON)	

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P 5	P 6	P 7	P 8	P 9	P10	P11	P12
1	-4.99	0.9892	0.9943	0.9948	0.9945	0.9956	0.9955	0.9955	0.9955
2	-4.99	0.9899	0.9954	0.9956	0.9952	0.9964	0.9963	0.9962	0.9963
3	-4.99	0.9899	0.9958	0.9963	0.9959	0.9971	0.9970	0.9970	0.9970
4	0.00	0.9314	0.9958	0.9981	0.9981	0.9990	0.9988	0.9995	0.9992
5	0.00	0.9266	0.9985	1.0010	1.0011	1.0016	1.0014	1.0021	1.0018
6	0.00	0.9358	0.9985	1.0010	1.0011	1.0020	1.0017	1.0024	1.0022
7	4.98	0.8224	0.9239	0.9854	0.9970	0.9982	0.9981	0.9992	0.9981
8	4.98	0.8125	0.9209	0.9846	0.9963	0.9971	0.9970	0.9981	0.9974
9	4.98	0.8154	0.9239	0.9854	0.9963	0.9975	0.9974	0.9984	0.9977
10	9.97	0.4763	0.5662	0.7999	0.9735	0.9967	0.9970	0.9984	0.9974
11	9.97	0.4734	0.5696	0.8039	0.9779	1.0001	0.9999	1.0014	1.0003
12	9.97	0.4756	0.5836	0.6144	0.9812	1.0016	1.0021	1.0035	1.0025
13	14.97	0.5961	0.5881	0.6019	0.6255	0.7378	0.9116	0.9889	0.9959
14	14.97	0.5990	0.5919	0.6048	0.6280	0.7491	0.9171	0.9908	0.9974
15	14.97	0.5979	0.5866	0.5978	0.6247	0.7371	0.9153	0.9922	0.9985
16	19.97	0.7085	0.8327	0.8075	0.8029	0.7967	0.8175	0.8940	0.9691
17	25.06	0.9329	0.9774	0.9617	0.9350	0.9121	0.9032	0.9290	0.9661
18	25.06	0.9380	0.9785	0.9625	0.9379	0.9113	0.9007	0.9287	0.9672
19	25.06	0.9460	0.9834	0.9668	0.9387	0.9143	0.9069	0.9345	0.9680
20	29.94	0.8059	0.8229	0.8595	0.8924	0.9346	0.9678	0.9886	0.9944
21	29.94	0.8553	0.8689	0.8832	0.9053	0.9327	0.9601	0.9809	0.9885
22	29.94	0.8147	0.8403	0.8621	0.8961	0.9319	0.9609	0.9787	0.9849

NAAL	RUN	CONFIGURATION	BETA
838	22	SPACE SHUTTLE RAKE PRESSURES ON FORWARD PART OF OMS (OMS ON)	

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P13	P14	P15	P16 Static Pressure Near Rake
1	-4.99	0.9980	0.9946	0.9924	0.1593
2	-4.99	0.9987	0.9954	0.9935	0.1597
3	-4.99	0.9995	0.9961	0.9938	0.1593
4	0.00	1.0024	0.9984	0.9967	0.2147
5	0.00	1.0049	1.0011	0.9996	0.2150
6	0.00	1.0056	1.0014	1.0003	0.2154
7	4.98	1.0013	0.9973	0.9964	0.2515
8	4.98	1.0002	0.9961	0.9953	0.2529
9	4.98	1.0006	0.9965	0.9956	0.2505
10	9.97	1.0006	0.9958	0.9949	0.0658
11	9.97	1.0038	0.9992	0.9982	0.0665
12	9.97	1.0056	1.0007	0.9996	0.0668
13	14.97	0.9995	0.9935	0.9935	0.0414
14	14.97	1.0009	0.9950	0.9949	0.0432
15	14.97	1.0016	0.9958	0.9956	0.0418
16	19.97	0.9962	0.9931	0.9942	0.0255
17	25.06	0.9896	0.9905	0.9913	0.0404
18	25.06	0.9958	0.9927	0.9942	0.0414
19	25.06	0.9944	0.9950	0.9956	0.0435
20	29.94	0.9976	0.9893	0.9877	0.1489
21	29.94	0.9915	0.9841	0.9830	0.1308
22	29.94	0.9878	0.9791	0.9780	0.1531

MAAL	RUN	CONFIGURATION	BETA
933	22	SPACE SHUTTLE RAKE PRESSURES ON FORWARD PART OF OMS (OMS ON)	

VELOCITY PROFILE - FEET PER SECOND

PT	ALPHA	V 5	V 6	V 7	V 8	V 9	V10	V11	V12	V13	V14	V15
1	-4.99	166.59	167.03	167.07	167.04	167.13	167.13	167.13	167.13	167.34	167.05	166.86
2	-4.99	166.66	167.12	167.13	167.10	167.20	167.19	167.19	167.19	167.40	167.12	166.95
3	-4.99	166.66	167.15	167.19	167.16	167.26	167.25	167.25	167.25	167.46	167.18	166.99
4	0.00	161.65	167.15	167.34	167.34	167.42	167.40	167.46	167.44	167.70	167.37	167.23
5	0.00	161.24	167.37	167.59	167.59	167.64	167.62	167.68	167.65	167.91	167.59	167.47
6	0.00	162.03	167.37	167.59	167.59	167.67	167.65	167.71	167.68	167.97	167.62	167.53
7	4.98	151.90	161.00	166.27	167.25	167.35	167.34	167.43	[illegible]	167.61	167.27	167.20
8	4.98	150.98	160.74	166.21	167.19	167.26	167.25	167.34	167.28	167.52	167.18	167.11
9	4.98	151.25	161.00	166.27	167.19	167.29	167.28	167.37	167.31	167.55	167.21	167.14
10	9.97	115.61	126.04	149.80	165.27	167.23	167.25	167.37	167.28	167.55	167.15	167.08
11	9.97	115.25	126.42	150.18	165.64	167.51	167.49	167.62	167.53	167.82	167.43	167.35
12	9.97	115.52	127.96	151.16	165.92	167.64	167.68	167.80	167.71	167.97	167.56	167.47
13	14.97	129.33	128.45	129.95	132.47	143.88	159.93	166.57	167.16	167.46	166.96	166.95
14	14.97	129.64	128.86	130.26	132.74	144.97	160.41	166.73	167.28	167.58	167.08	167.08
15	14.97	129.52	128.29	129.51	132.39	143.81	160.25	166.85	167.37	167.64	167.15	167.14
16	19.97	140.99	152.85	150.52	150.09	143.51	151.45	158.37	164.89	167.18	166.92	167.02
17	25.06	161.78	165.60	164.27	161.97	159.97	159.19	161.45	164.64	165.63	166.70	166.77
18	25.06	162.22	165.69	164.33	162.22	159.90	158.97	161.42	164.73	167.15	166.89	167.02
19	25.06	162.92	166.11	164.70	162.28	160.17	159.51	161.92	164.80	167.03	167.08	167.14
20	29.94	150.37	151.95	155.29	158.24	161.93	164.78	166.54	167.04	167.30	166.61	166.47
21	29.94	154.91	156.14	157.41	159.37	161.77	164.13	165.89	166.54	166.79	166.16	166.07
22	29.94	151.19	153.54	155.52	158.56	161.70	164.19	165.71	166.23	166.48	165.75	165.65

IAAL	RUN	CONFIGURATION	BETA	RD.
838	23	SPACE SHUTTLE RAKE PRESSURES ON AFT PART OF OMS (OMS ON)		1

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P 5	P 6	P 7	P 8	P 9	P10	P11	P12
1	-4.99	0.9866	0.9954	0.9934	0.9952	0.9967	0.9970	0.9966	0.9974
2	-4.99	0.9877	0.9958	0.9941	0.9959	0.9975	0.9981	0.9973	0.9981
3	-4.99	0.9866	0.9958	0.9937	0.9956	0.9975	0.9977	0.9970	0.9981
4	0.00	0.9083	0.9906	0.9948	0.9959	0.9971	0.9970	0.9966	0.9974
5	0.00	0.9098	0.9894	0.9934	0.9945	0.9956	0.9955	0.9951	0.9959
6	0.00	0.9124	0.9902	0.9937	0.9945	0.9956	0.9955	0.9955	0.9959
7	4.97	0.8077	0.9567	0.9992	1.0007	1.0016	1.0014	1.0014	1.0018
8	4.97	0.8011	0.9514	0.9963	0.9978	0.9986	0.9985	0.9981	0.9988
9	4.97	0.8044	0.9533	0.9941	0.9956	0.9967	0.9966	0.9966	0.9970
10	9.98	0.5558	0.6725	0.8624	0.9783	0.9982	0.9999	1.0003	1.0003
11	9.98	0.5617	0.6827	0.8701	0.9823	1.0005	1.0014	1.0014	1.0014
12	9.98	0.5602	0.6771	0.8686	0.9838	1.0009	1.0017	1.0017	1.0018
13	14.97	0.6089	0.6013	0.6390	0.7320	0.8604	0.9605	0.9904	0.9937
14	14.97	0.6086	0.6032	0.6393	0.7335	0.8638	0.9656	0.9911	0.9937
15	14.97	0.6034	0.6017	0.6430	0.7346	0.8675	0.9649	0.9922	0.9952
16	19.97	0.6979	0.7487	0.8042	0.8245	0.8413	0.8970	0.9608	0.9889
17	19.97	0.6906	0.7442	0.8039	0.8322	0.8533	0.9036	0.9670	0.9944
18	19.97	0.7012	0.7547	0.8122	0.8337	0.8499	0.9043	0.9729	0.9988
19	24.97	0.8838	0.8979	0.9137	0.9049	0.9155	0.9445	0.9794	0.9937
20	29.95	0.8070	0.8546	0.9155	0.9684	0.9881	0.9941	0.9941	0.9937
21	29.96	0.7927	0.8440	0.9188	0.9735	0.9870	0.9893	0.9889	0.9885
22	29.95	0.7759	0.8229	0.8952	0.9607	0.9844	0.9908	0.9911	0.9908

NAAL	RUN	CONFIGURATION	BETA
83A	23	SPACE SHUTTLE RAKE PRESSURES ON AFT PART OF OMS (OMS ON)	

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P13	P14	P15	P16 Static Pressure Near Rake
1	-4.99	0.9991	0.9969	0.9964	-0.1862
2	-4.99	0.9995	0.9973	0.9971	-0.1876
3	-4.99	0.9995	0.9973	0.9967	-0.1876
4	0.00	0.9987	0.9965	0.9964	-0.1633
5	0.00	0.9973	0.9950	0.9949	-0.1626
6	0.00	0.9973	0.9950	0.9953	-0.1615
7	4.97	1.0031	1.0007	1.0007	-0.1462
8	4.97	1.0002	0.9977	0.9978	-0.1445
9	4.97	0.9984	0.9961	0.9960	-0.1442
10	9.98	1.0016	0.9988	0.9996	-0.1671
11	9.98	1.0031	0.9999	1.0007	-0.1689
12	9.98	1.0035	1.0003	1.0007	-0.1682
13	14.97	0.9947	0.9905	0.9928	-0.1609
14	14.97	0.9951	0.9905	0.9931	-0.1612
15	14.97	0.9962	0.9916	0.9942	-0.1619
16	19.97	0.9944	0.9897	0.9928	-0.1661
17	19.97	0.9995	0.9943	0.9974	-0.1675
18	19.97	1.0042	0.9988	1.0021	-0.1695
19	24.97	0.9966	0.9909	0.9935	-0.1883
20	29.95	0.9929	0.9837	0.9852	-0.1459
21	29.96	0.9875	0.9776	0.9801	-0.1452
22	29.95	0.9896	0.9799	0.9823	-0.1438

IAAL RUN CONFIGURATION BETA F

838 23 SPACE SHUTTLE RAKE PRESSURES ON AFT PART OF OMS (OMS ON)

VELOCITY PROFILE - FEET PER SECOND

PT	ALPHA	V 5	V 6	V 7	V 8	V 9	V10	V11	V12	V13	V14	V15
1	-4.99	166.38	167.12	166.95	167.10	167.23	167.25	167.22	167.28	167.43	167.24	167.20
2	-4.99	166.47	167.15	167.01	167.16	167.29	167.34	167.28	167.34	167.46	167.27	167.26
3	-4.99	166.38	167.15	166.98	167.13	167.29	167.31	167.25	167.34	167.46	167.27	167.23
4	0.00	159.64	166.71	167.07	167.16	167.26	167.25	167.22	167.28	167.40	167.21	167.20
5	0.00	159.77	166.61	166.95	167.04	167.13	167.13	167.09	167.16	167.27	167.08	167.08
6	0.00	159.99	166.68	166.98	167.04	167.13	167.13	167.13	167.16	167.27	167.08	167.11
7	4.97	150.54	163.83	167.43	167.56	167.54	167.62	167.62	167.65	167.76	167.56	167.56
8	4.97	149.92	163.38	167.19	167.31	167.39	167.37	167.34	167.41	167.52	167.31	167.32
9	4.97	150.23	163.54	167.01	167.13	167.23	167.22	167.22	167.25	167.37	167.18	167.17
10	9.98	124.88	137.37	155.55	165.68	167.35	167.49	167.52	167.53	167.64	167.40	167.47
11	9.98	125.54	138.40	156.24	166.02	167.54	167.62	167.62	167.62	167.76	167.50	167.56
12	9.98	125.37	137.83	156.11	166.14	167.57	167.65	167.65	167.65	167.79	167.53	167.56
13	14.97	130.71	129.89	133.90	143.31	155.37	164.16	166.70	166.97	167.06	166.70	166.89
14	14.97	130.67	130.09	133.93	143.45	155.67	164.60	166.76	166.97	167.09	166.70	166.92
15	14.97	130.12	129.93	134.31	143.56	156.01	164.54	166.85	167.10	167.18	166.80	167.02
16	19.97	139.93	144.93	150.21	152.10	153.63	158.64	164.19	166.57	167.03	166.64	166.89
17	19.97	139.20	144.50	150.18	152.81	154.73	159.22	164.72	167.04	167.46	167.02	167.29
18	19.97	140.26	145.52	150.96	152.94	154.42	159.29	165.21	167.41	167.85	167.40	167.68
19	24.97	157.47	158.72	160.11	159.34	160.27	162.78	165.77	166.97	167.21	166.73	166.95
20	29.95	150.47	154.84	160.27	164.83	166.50	167.00	167.00	166.97	166.91	166.13	166.26
21	29.96	149.13	153.89	160.56	165.27	166.41	165.61	166.57	166.54	166.45	165.62	165.83
22	29.95	147.54	151.95	158.48	164.18	166.19	165.73	166.76	166.73	165.63	165.81	166.01

VAAL RUN CONFIGURATION BETA

839 24 SPACE SHUTTLE RAKE PRESSURES AHEAD OF OMS (OMS REMOVED)

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P 5	P 6	P 7	P 8	P 9	P10	P11	P12
1	-5.00	0.7594	0.9536	0.9963	0.9981	0.9994	0.9995	0.9992	1.0003
2	-5.00	0.7546	0.9503	0.9945	0.9963	0.9971	0.9974	0.9970	0.9981
3	-5.00	0.7568	0.9506	0.9919	0.9934	0.9949	0.9948	0.9944	0.9955
4	0.00	0.5793	0.7415	0.6799	0.9776	0.9967	0.9977	0.9973	0.9981
5	0.00	0.5818	0.7404	0.6806	0.9801	0.9997	1.0006	1.0003	1.0007
6	0.01	0.5763	0.7427	0.6810	0.9820	1.0012	1.0017	1.0014	1.0022
7	4.98	0.4620	0.6552	0.7653	0.8620	0.9480	0.9933	1.0014	1.0033
8	4.98	0.4602	0.6526	0.7642	0.8623	0.9477	0.9933	1.0006	1.0018
9	4.98	0.4551	0.6556	0.7704	0.8708	0.9495	0.9923	0.9995	1.0007
10	9.98	0.4558	0.4942	0.4358	0.5299	0.7382	0.9817	0.9966	0.9974
11	9.98	0.4565	0.4972	0.4391	0.5332	0.7978	0.9831	0.9992	0.9996
12	9.98	0.4587	0.4968	0.4402	0.5384	0.8019	0.9853	1.0014	1.0018
13	14.95	0.6360	0.6986	0.6350	0.5902	0.5699	0.5458	0.6382	0.8602
14	14.95	0.6316	0.6940	0.6368	0.5928	0.5680	0.5473	0.6535	0.8716
15	14.96	0.6364	0.6978	0.6353	0.5935	0.5714	0.5491	0.6429	0.8558
16	19.96	0.5994	0.8900	0.8777	0.8208	0.7645	0.7332	0.7390	0.7417
17	19.96	0.6045	0.8953	0.8832	0.8205	0.7667	0.7321	0.7442	0.7498
18	19.96	0.6001	0.8975	0.8868	0.8238	0.7686	0.7397	0.7482	0.7509
19	24.97	0.5349	0.8802	0.9526	0.9666	0.9679	0.9569	0.9352	0.9109
20	24.97	0.5730	0.9122	0.9657	0.9735	0.9728	0.9598	0.9411	0.9154
21	24.97	0.5507	0.8926	0.9592	0.9706	0.9728	0.9609	0.9389	0.9142
22	29.97	0.3671	0.5051	0.6721	0.7918	0.8533	0.8912	0.9122	0.9341
23	29.97	0.3840	0.5115	0.6698	0.7973	0.8653	0.9054	0.9236	0.9510
24	29.97	0.3796	0.5357	0.6939	0.8117	0.8712	0.9032	0.9236	0.9510

JAAL RUN CONFIGURATION BETA

83A 24 SPACE SHUTTLE RAKE PRESSURES AHEAD OF OMS (OMS REMOVED)

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P13	P14	P15	P16 Static Pressure Near Rake
1	-5.00	1.0013	0.9995	0.9999	-0.0663
2	-5.00	0.9991	0.9977	0.9967	-0.0649
3	-5.00	0.9962	0.9950	0.9942	-0.0642
4	0.00	0.9995	0.9977	0.9971	-0.0729
5	0.00	1.0020	1.0007	1.0000	-0.0732
6	0.01	1.0035	1.0018	1.0011	-0.0732
7	4.98	1.0038	1.0018	1.0021	-0.1014
8	4.98	1.0027	1.0007	1.0011	-0.1010
9	4.98	1.0016	0.9995	0.9996	-0.1003
10	9.98	0.9980	0.9935	0.9964	-0.1459
11	9.98	1.0002	0.9958	0.9989	-0.1469
12	9.98	1.0024	0.9980	1.0007	-0.1476
13	14.95	0.9747	0.9788	0.9910	-0.1612
14	14.95	0.9765	0.9788	0.9910	-0.1615
15	14.96	0.9725	0.9788	0.9917	-0.1609
16	19.96	0.7637	0.8341	0.9430	-0.1970
17	19.96	0.7651	0.8341	0.9408	-0.1991
18	19.96	0.7669	0.8447	0.9509	-0.2002
19	24.97	0.8790	0.8704	0.9191	-0.2214
20	24.97	0.8838	0.8738	0.9152	-0.2304
21	24.97	0.8863	0.8790	0.9260	-0.2283
22	29.97	0.9562	0.9671	0.9666	-0.3905
23	29.97	0.9711	0.9791	0.9946	-0.3877
24	29.97	0.9762	0.9833	0.9999	-0.4030

VAAL RUN CONFIGURATION BETA

839 24 . SPACE SHUTTLE RAKE PRESSURES AHEAD OF OMS (OMS REMOVED)

VELOCITY PROFILE - FEET PER SECOND

PT	ALPHA	V 5	V 6	V 7	V 8	V 9	V10	V11	V12	V13	V14	V15
1	-5.00	145.97	163.57	167.19	167.34	167.45	167.46	167.43	167.53	167.61	167.46	167.41
2	-5.00	145.51	163.28	167.04	167.19	167.26	167.28	167.25	167.34	167.43	167.31	167.23
3	-5.00	145.72	163.32	166.82	166.94	167.07	167.07	167.03	167.13	167.18	167.08	167.02
4	0.00	127.49	144.24	157.12	165.61	167.23	167.31	167.28	167.34	167.46	167.31	167.26
5	0.00	127.77	144.13	157.19	165.83	167.48	167.56	167.52	167.56	167.67	167.56	167.50
6	0.01	127.16	144.35	157.22	165.99	167.60	167.65	167.62	167.68	167.79	167.65	167.59
7	4.98	113.86	135.58	146.53	155.51	163.09	166.94	167.62	167.77	167.82	167.65	167.68
8	4.98	113.63	135.31	146.43	155.55	163.06	166.94	167.55	167.65	167.73	167.56	167.59
9	4.98	113.00	135.62	147.02	156.30	163.22	166.85	167.46	167.56	167.64	167.46	167.47
10	9.98	113.09	117.75	110.58	121.94	149.65	165.96	167.22	167.28	167.34	166.96	167.20
11	9.98	113.18	118.11	110.99	122.32	149.61	166.08	167.43	167.47	167.52	167.15	167.41
12	9.98	113.45	118.07	111.13	122.91	150.00	165.27	167.62	167.65	167.70	167.34	167.56
13	14.95	133.59	140.00	133.48	128.68	126.45	123.75	133.81	155.35	165.37	165.71	166.74
14	14.95	133.12	139.54	133.67	128.96	126.24	123.92	135.41	156.38	165.53	165.71	166.74
15	14.96	133.62	139.92	133.51	129.04	126.62	124.12	134.31	154.95	165.19	165.71	166.80
16	19.96	129.68	158.02	156.93	151.76	146.45	143.42	144.00	144.25	146.38	152.98	162.65
17	19.96	130.24	158.49	157.41	151.72	146.67	143.32	144.50	145.04	146.52	152.98	162.47
18	19.96	129.76	158.69	157.74	152.03	146.85	144.06	144.89	145.15	146.69	153.94	163.34
19	24.97	122.51	157.15	163.49	164.68	164.79	163.85	161.99	159.87	157.05	156.27	160.59
20	24.97	126.80	159.98	164.61	165.27	165.21	164.10	162.49	160.26	157.47	156.57	160.24
21	24.97	124.30	158.25	164.05	165.02	165.21	164.19	162.30	160.16	157.69	157.05	161.18
22	29.97	101.49	119.05	137.32	149.05	154.73	158.13	159.98	161.89	163.79	164.72	166.38
23	29.97	103.80	119.80	136.99	149.57	155.81	159.38	160.97	163.35	165.06	165.75	167.05
24	29.97	103.20	122.59	139.54	150.91	156.35	159.19	160.97	163.35	165.50	166.10	167.41

NAAL	RUN	CONFIGURATION	BETA	RC
83A	26	SPACE SHUTTLE RAKE PRESSURES ON INBOARD ELEVON		1

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P 5	P 6	P 7	P 8	P 9	P10	P11	P12
1	-4.99	0.9559	0.9981	0.9956	0.9963	0.9967	0.9966	0.9959	0.9966
2	-4.99	0.9538	0.9992	0.9966	0.9974	0.9979	0.9981	0.9970	0.9981
3	-4.99	0.9574	0.9996	0.9970	0.9974	0.9979	0.9981	0.9973	0.9981
4	0.00	0.8794	1.0003	0.9981	0.9981	0.9990	0.9992	0.9981	0.9988
5	0.01	0.8791	1.0015	0.9992	0.9992	0.9997	1.0003	0.9995	1.0003
6	0.00	0.8802	1.0019	0.9996	0.9996	1.0001	1.0006	0.9999	1.0007
7	4.98	0.6994	0.9977	0.9956	0.9952	0.9960	0.9963	0.9959	0.9963
8	4.98	0.6990	0.9996	0.9974	0.9974	0.9979	0.9981	0.9977	0.9981
9	4.98	0.6997	1.0022	0.9999	1.0000	1.0005	1.0010	1.0006	1.0011
10	10.04	0.4448	0.3912	0.6182	0.9790	0.9960	0.9970	0.9973	0.9970
11	10.04	0.4463	0.3938	0.6230	0.9765	0.9945	0.9955	0.9959	0.9955
12	10.04	0.4459	0.3961	0.6237	0.9776	0.9941	0.9952	0.9951	0.9948
13	15.02	0.5240	0.5794	0.6652	0.7794	0.8480	0.8941	0.9287	0.9613
14	15.02	0.5280	0.5753	0.6652	0.7772	0.8476	0.8937	0.9345	0.9635
15	15.02	0.5514	0.5896	0.6747	0.7893	0.8570	0.8974	0.9279	0.9595
16	19.96	0.2297	0.5293	0.5640	0.5678	0.6213	0.6236	0.6319	0.6555
17	19.96	0.2355	0.5353	0.5654	0.5722	0.6276	0.6280	0.6356	0.6566
18	19.96	0.2359	0.5353	0.5698	0.5744	0.6284	0.6295	0.6403	0.6633
19	24.97	-1.0742	-0.8407	-0.9246	-1.1084	-1.1136	-1.1603	-1.2052	-1.2010
20	24.97	-1.1340	-0.9106	-1.0126	-1.2098	-1.2084	-1.2408	-1.2730	-1.2594
21	24.97	-1.0870	-0.8498	-0.9400	-1.1191	-1.1099	-1.1676	-1.2385	-1.2365
22	29.96	-0.4444	-0.3069	-0.3768	-0.4608	-0.4933	-0.5528	-0.6121	-0.6499
23	29.96	-0.4690	-0.3189	-0.3757	-0.4571	-0.4899	-0.5550	-0.6183	-0.6603
24	29.96	-0.4624	-0.3201	-0.3768	-0.4593	-0.4899	-0.5543	-0.6329	-0.6662

NAAL RUN CONFIGURATION BETA

83A 26 SPACE SHUTTLE RAKE PRESSURES ON INBOARD ELEVON

DYNAMIC PRESSURE (Q)= 33.36 PSF

PT	ALPHA	P13	P14	P15	P16 Static Pressure Near Rake
1	-4.99	0.9976	0.9961	0.9956	-0.1296
2	-4.99	0.9987	0.9973	0.9947	-0.1299
3	-4.99	0.9987	0.9973	0.9967	-0.1299
4	0.00	0.9995	0.9977	0.9974	-0.1226
5	0.01	1.0006	0.9988	0.9985	-0.1229
6	0.00	1.0009	0.9992	0.9989	-0.1229
7	4.98	0.9962	0.9935	0.9946	-0.1132
8	4.98	0.9984	0.9954	0.9967	-0.1142
9	4.98	1.0009	0.9980	0.9993	-0.1149
10	10.04	0.9955	0.9909	0.9935	-0.1511
11	10.04	0.9940	0.9893	0.9920	-0.1508
12	10.04	0.9936	0.9890	0.9917	-0.1511
13	15.02	0.9704	0.9712	0.9744	-0.3724
14	15.02	0.9729	0.9742	0.9765	-0.3724
15	15.02	0.9667	0.9708	0.9747	-0.3776
16	19.96	0.6344	0.6436	0.6815	-0.3452
17	19.96	0.6417	0.6508	0.6902	-0.3376
18	19.96	0.6424	0.6478	0.6877	-0.3449
19	24.97	-1.2283	-1.1965	-1.1602	-1.3199
20	24.97	-1.2695	-1.2367	-1.1954	-1.3345
21	24.97	-1.2597	-1.2253	-1.1849	-1.3254
22	29.96	-0.7079	-0.7290	-0.7606	-0.8830
23	29.96	-0.7046	-0.7173	-0.7331	-0.8942
24	29.96	-0.7419	-0.7578	-0.7707	-0.8914

IAAL	RUN	CONFIGURATION	BETA	RI
833	26	SPACE SHUTTLE RAKE PRESSURES ON INBOARD ELEVON		

VELOCITY PROFILE - FEET PER SECOND

PT	ALPHA	V 5	V 6	V 7	V 8	V 9	V10	V11	V12	V13	V14	V15
1	-4.99	163.77	167.34	167.13	167.19	167.23	167.22	167.16	167.22	167.30	167.18	167.14
2	-4.99	164.02	167.44	167.22	167.28	167.32	167.34	167.25	167.34	167.40	167.27	167.23
3	-4.99	163.89	167.47	167.25	167.28	167.32	167.34	167.28	167.34	167.40	167.27	167.23
4	0.00	157.08	167.53	167.34	167.34	167.42	167.43	167.34	167.41	167.46	167.31	167.29
5	0.01	157.05	167.63	167.43	167.44	167.48	167.53	167.46	167.53	167.55	167.40	167.38
6	0.00	157.15	167.66	167.46	167.47	167.51	167.56	167.49	167.56	167.58	167.43	167.41
7	4.98	140.08	167.31	167.13	167.10	167.17	167.19	167.16	167.19	167.18	166.96	167.05
8	4.98	140.04	167.47	167.28	167.28	167.32	167.34	167.31	167.34	167.37	167.12	167.23
9	4.98	140.12	167.69	167.50	167.50	167.54	167.59	167.55	167.59	167.58	167.34	167.44
10	10.04	111.72	104.77	131.70	165.74	167.17	167.25	167.28	167.25	167.12	166.73	166.95
11	10.04	111.90	105.12	132.21	165.52	167.04	167.13	167.16	167.13	167.00	166.61	166.83
12	10.04	111.85	105.42	132.28	165.61	167.01	167.10	167.09	167.07	166.97	166.58	166.80
13	15.02	121.25	127.50	136.61	147.87	154.25	158.39	161.42	164.23	165.00	165.07	165.34
14	15.02	121.71	127.05	136.61	147.66	154.22	158.35	161.92	164.42	165.22	165.33	165.52
15	15.02	124.38	128.62	137.58	148.61	155.07	158.68	161.35	164.07	164.69	165.04	165.37
16	19.96	80.28	121.86	125.79	126.22	132.03	132.28	133.16	135.62	133.42	134.38	138.28
17	19.96	81.29	122.55	125.96	126.70	132.70	132.74	133.54	135.73	134.18	135.13	139.16
18	19.96	81.36	122.55	126.44	126.95	132.78	132.89	134.04	136.42	134.26	134.81	138.90

NAAL	RUN	CONFIGURATION	BETA
83A	27	SPACE SHUTTLE RAKE PRESSURES ON OUTBOARD ELEVON	

DYNAMIC PRESSURE (Q)= 33.36 PSF

PI	ALPHA	P 5	P 6	P 7	P 8	P 9	P10	P11	P12
1	-4.98	0.9925	0.9962	0.9937	0.9934	0.9945	0.9944	0.9941	0.9952
2	-4.98	0.9943	0.9981	0.9952	0.9952	0.9964	0.9963	0.9959	0.9966
3	-4.98	0.9965	1.0003	0.9974	0.9974	0.9986	0.9985	0.9981	0.9988
4	0.01	0.9815	0.9985	0.9956	0.9959	0.9967	0.9966	0.9962	0.9970
5	0.01	0.9830	0.9996	0.9966	0.9967	0.9979	0.9974	0.9973	0.9981
6	0.01	0.9826	1.0003	0.9974	0.9978	0.9986	0.9981	0.9981	0.9988
7	4.98	0.9025	0.9996	0.9959	0.9970	0.9975	0.9974	0.9973	0.9977
8	4.98	0.9010	0.9996	0.9956	0.9967	0.9975	0.9974	0.9970	0.9977
9	4.98	0.9036	1.0000	0.9959	0.9970	0.9979	0.9974	0.9973	0.9977
10	9.98	0.6492	0.9988	0.9937	0.9963	0.9956	0.9959	0.9962	0.9955
11	9.98	0.6507	1.0015	0.9963	0.9989	0.9982	0.9985	0.9992	0.9985
12	9.98	0.6514	1.0037	0.9985	1.0011	1.0005	1.0006	1.0014	1.0007
13	14.94	-0.1755	0.1255	0.7263	0.9926	0.9896	0.9837	0.9900	0.9878
14	14.94	-0.1777	0.1319	0.7373	0.9963	0.9937	0.9937	0.9941	0.9915
15	14.94	-0.1817	0.1221	0.7293	0.9996	0.9967	0.9966	0.9970	0.9948
16	19.99	-1.0866	-0.6723	-0.5525	-0.5359	-0.4230	-0.3404	-0.2691	-0.1828
17	19.99	-1.1065	-0.6953	-0.5591	-0.5399	-0.4336	-0.3463	-0.2625	-0.1772
18	19.99	-1.0573	-0.5987	-0.4395	-0.3709	-0.2132	-0.0587	0.0985	0.1467
19	24.99	-1.3575	-0.8822	-0.6448	-0.8659	-0.7727	-0.6958	-0.7219	-0.7193
20	24.99	-1.3747	-0.9162	-0.6632	-0.8862	-0.7889	-0.7166	-0.7472	-0.7323
21	24.99	-1.4019	-0.9434	-0.6966	-0.9072	-0.8137	-0.7422	-0.7578	-0.7304
22	29.95	-0.7465	-0.7225	-0.6984	-0.7381	-0.7130	-0.6961	-0.6941	-0.6813
23	29.95	-0.7781	-0.7259	-0.6933	-0.7572	-0.7194	-0.7053	-0.7033	-0.6868
24	29.95	-0.7829	-0.7327	-0.7057	-0.7734	-0.7344	-0.7086	-0.7087	-0.6931

NAAL	RUN	CONFIGURATION	BETA
838	27	SPACE SHUTTLE RAKE PRESSURES ON OUTBOARD ELEVON	

DYNAMIC PRESSURE (Q) = 33.36 PSF

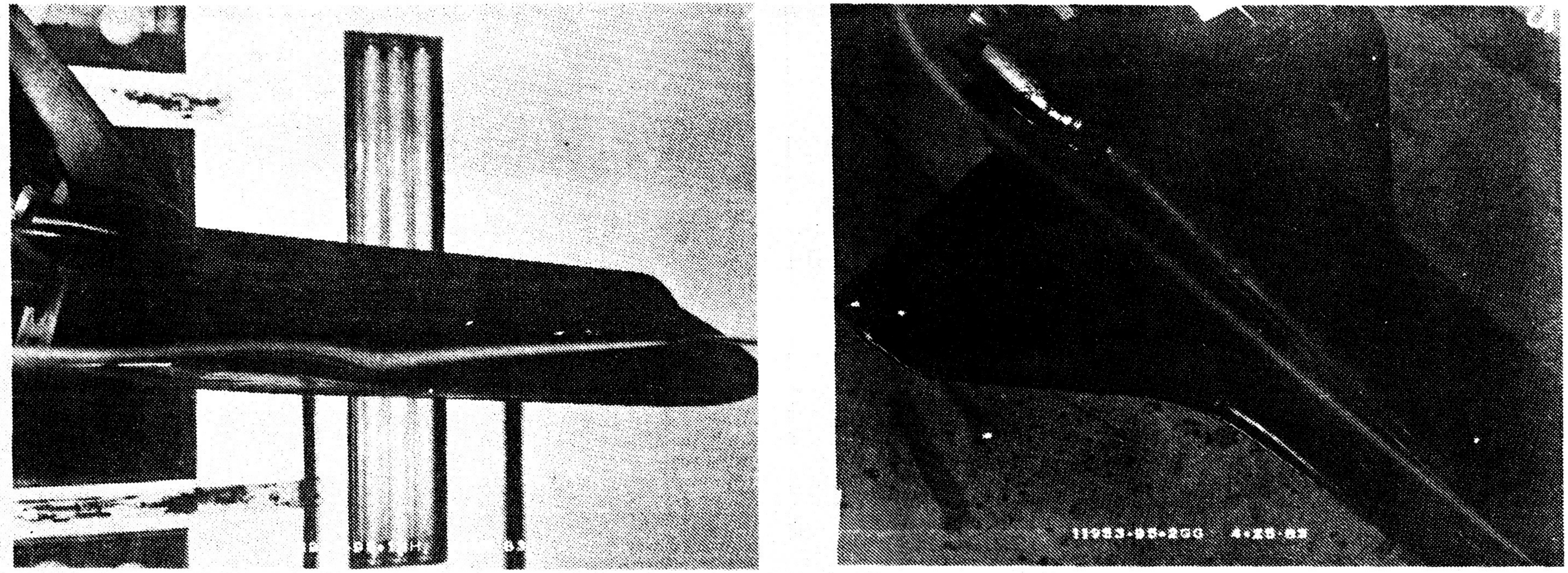
PT	ALPHA	P13	P14	P15	P16 Static Pressure Near Rake
1	-4.98	0.9955	0.9943	0.9942	0.0654
2	-4.98	0.9973	0.9961	0.9956	0.0647
3	-4.98	0.9995	0.9984	0.9982	0.0640
4	0.01	0.9976	0.9961	0.9960	0.0303
5	0.01	0.9967	0.9973	0.9971	0.0307
6	0.01	0.9991	0.9977	0.9974	0.0300
7	4.98	0.9980	0.9950	0.9964	-0.0158
8	4.98	0.9976	0.9950	0.9960	-0.0158
9	4.98	0.9980	0.9954	0.9964	-0.0158
10	9.98	0.9944	0.9890	0.9931	-0.0628
11	9.98	0.9973	0.9916	0.9960	-0.0638
12	9.98	0.9995	0.9939	0.9978	-0.0642
13	14.94	0.9842	0.9739	0.9819	-0.3139
14	14.94	0.9882	0.9776	0.9859	-0.3146
15	14.94	0.9911	0.9810	0.9888	-0.3170
16	19.99	-0.0670	0.0864	0.2489	-0.7277
17	19.99	-0.1144	0.0118	0.1863	-0.7371
18	19.99	0.4891	0.6867	0.6162	-0.7239
19	24.99	-0.8207	-0.8597	-0.9777	-0.7702
20	24.99	-0.8455	-0.8741	-0.9926	-0.7685
21	24.99	-0.8119	-0.8445	-0.9553	-0.7709
22	29.95	-0.6853	-0.6741	-0.6763	-0.6438
23	29.95	-0.6922	-0.6718	-0.6766	-0.6553
24	29.95	-0.7076	-0.6953	-0.6907	-0.6619

NAAL RUN CONFIGURATION BETA R

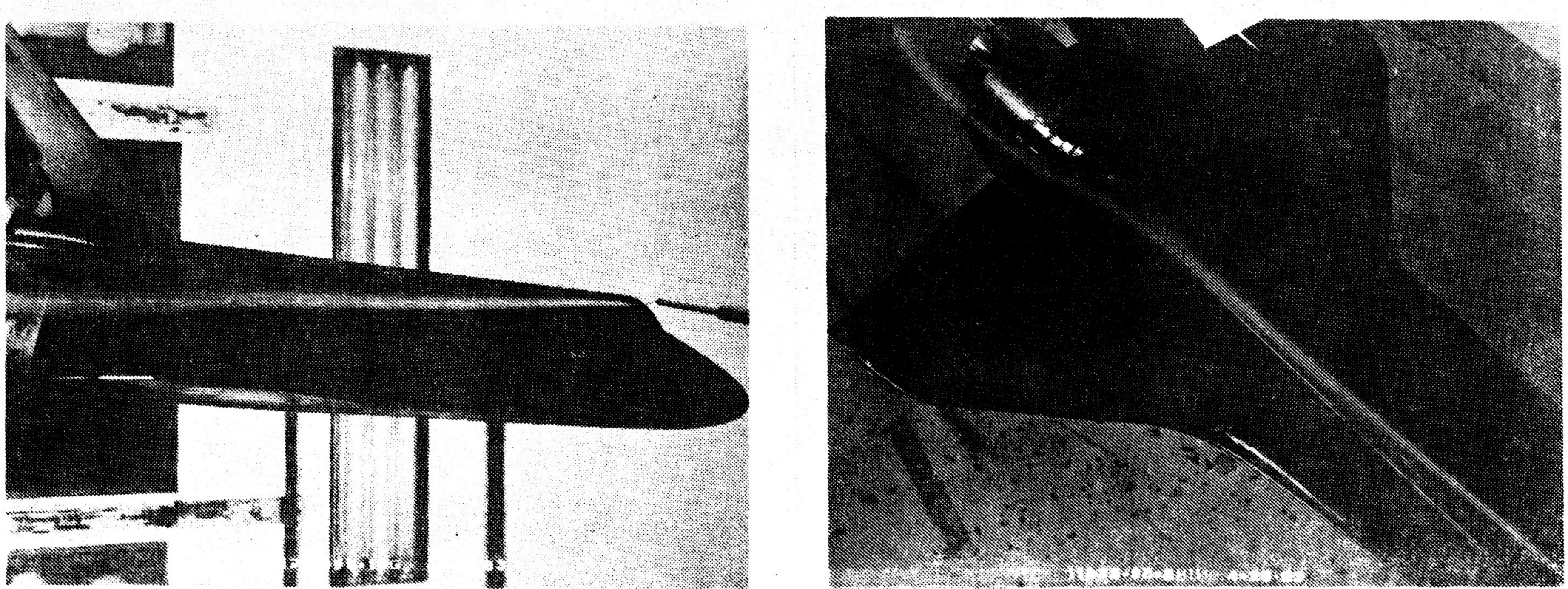
838 27 SPACE SHUTTLE RAKE PRESSURES ON OUTBOARD ELEVON

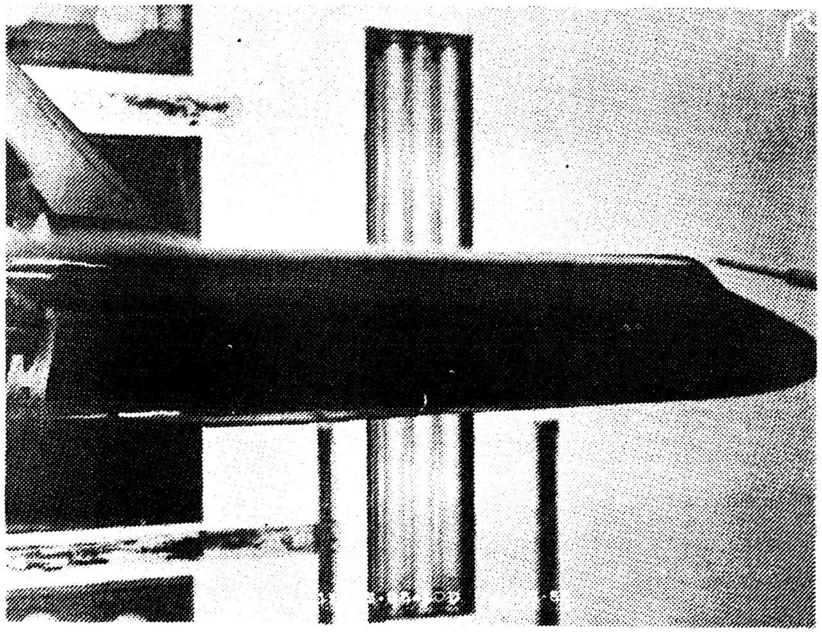
VELOCITY PROFILE - FEET PER SECOND

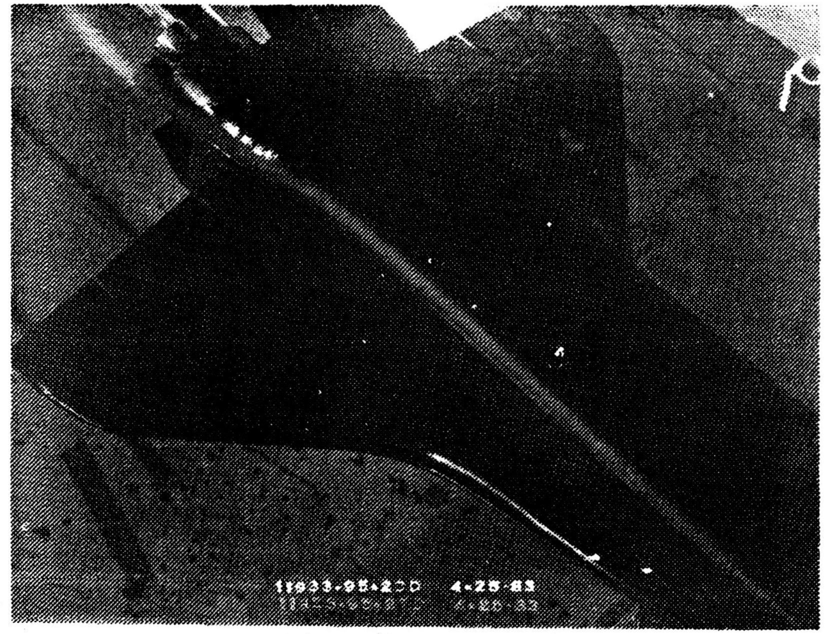
PT	ALPHA	V 5	V 6	V 7	V 8	V 9	V10	V11	V12	V13	V14	V15
1	-4.98	166.87	167.18	166.98	166.94	167.04	167.04	167.00	167.10	167.12	167.02	167.02
2	-4.98	167.02	167.34	167.10	167.10	167.20	167.19	167.16	167.22	167.27	167.18	167.14
3	-4.98	167.21	167.53	167.28	167.28	167.39	167.37	157.34	167.41	167.46	167.37	167.35
4	0.01	165.95	167.37	167.13	167.16	167.23	167.22	157.19	167.25	167.30	167.18	167.17
5	0.01	166.07	167.47	167.22	167.22	167.32	167.28	167.28	167.34	167.40	167.27	167.26
6	0.01	166.04	167.53	167.28	167.31	167.39	167.34	167.34	167.41	167.43	167.31	167.29
7	4.98	159.13	167.47	167.16	167.25	167.29	167.28	167.28	167.31	167.34	167.08	167.20
8	4.98	159.00	167.47	167.13	167.22	167.29	167.28	167.25	167.31	167.30	167.08	167.17
9	4.98	159.22	167.50	167.16	167.25	167.32	167.28	167.28	167.31	167.34	167.12	167.20
10	9.98	134.96	167.40	166.98	167.19	167.13	167.16	167.19	167.13	167.03	166.58	166.92
11	9.98	135.11	167.63	167.19	167.41	167.35	167.37	167.43	167.37	167.27	166.80	167.17
12	9.98	135.19	167.81	167.37	167.59	167.54	167.56	167.62	167.56	167.46	166.99	167.32



Angle of Attack = -5 Degrees







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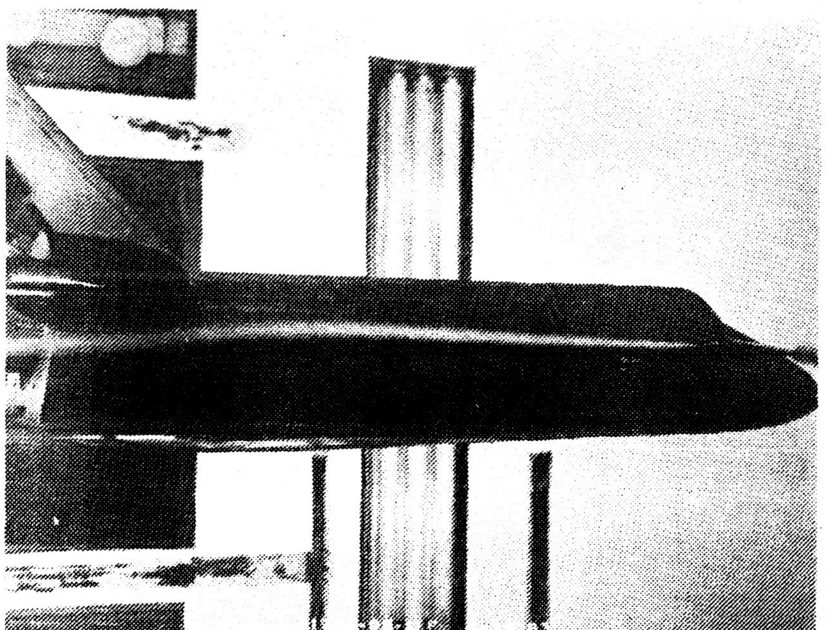

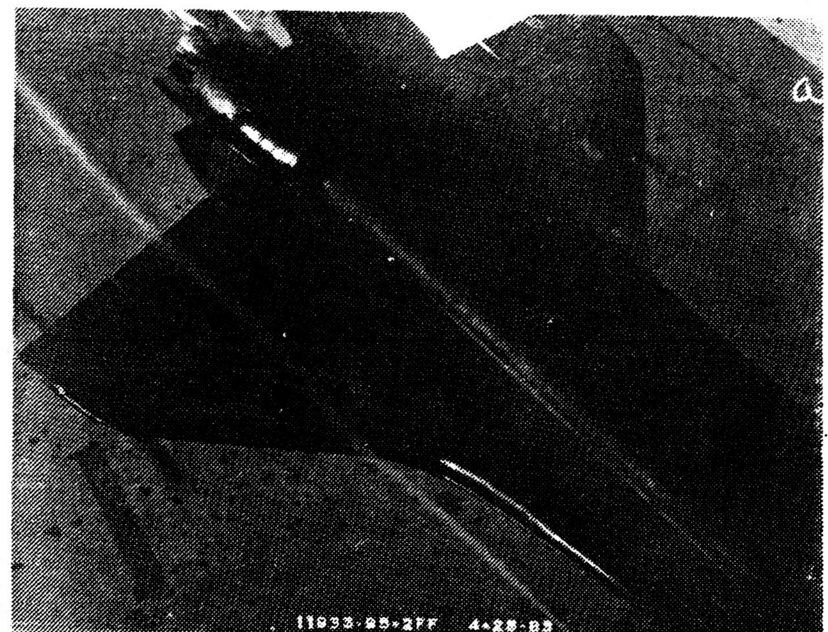

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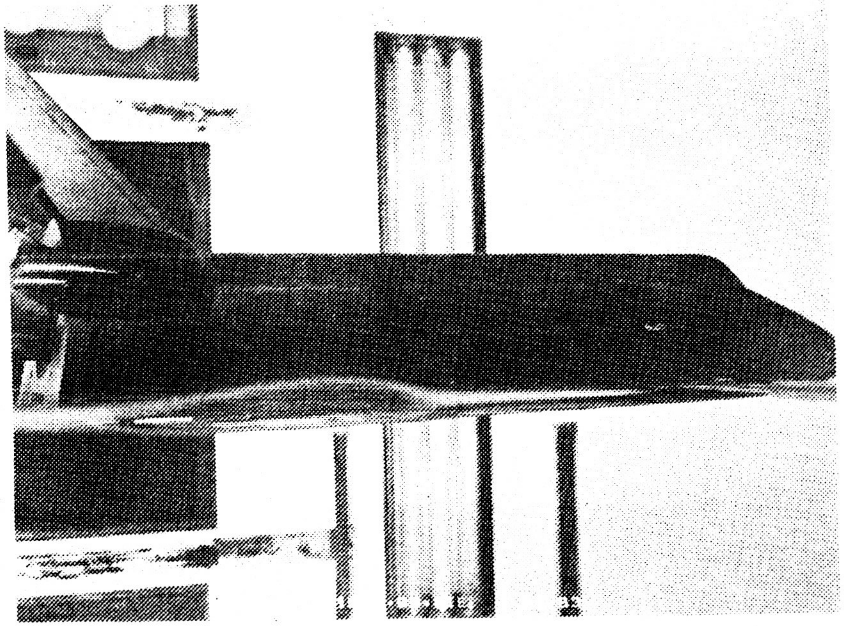
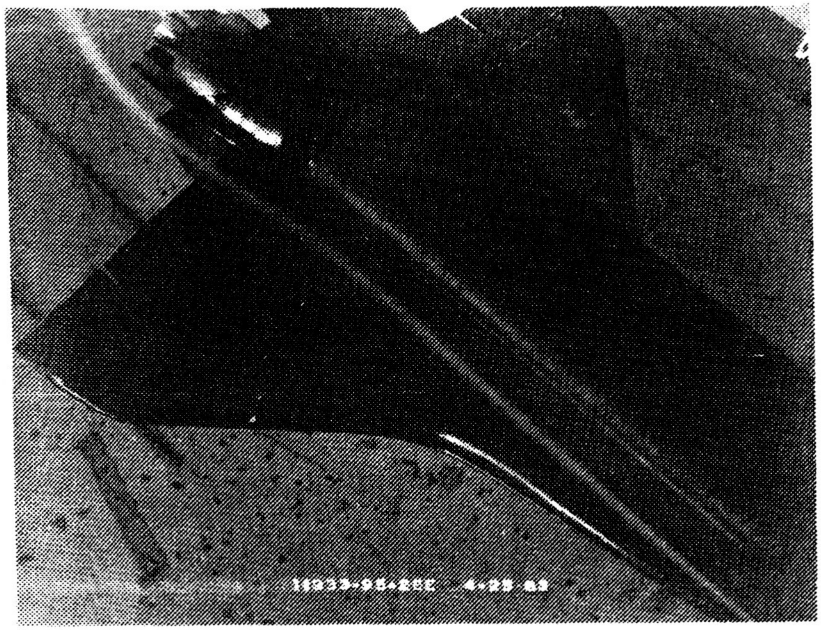
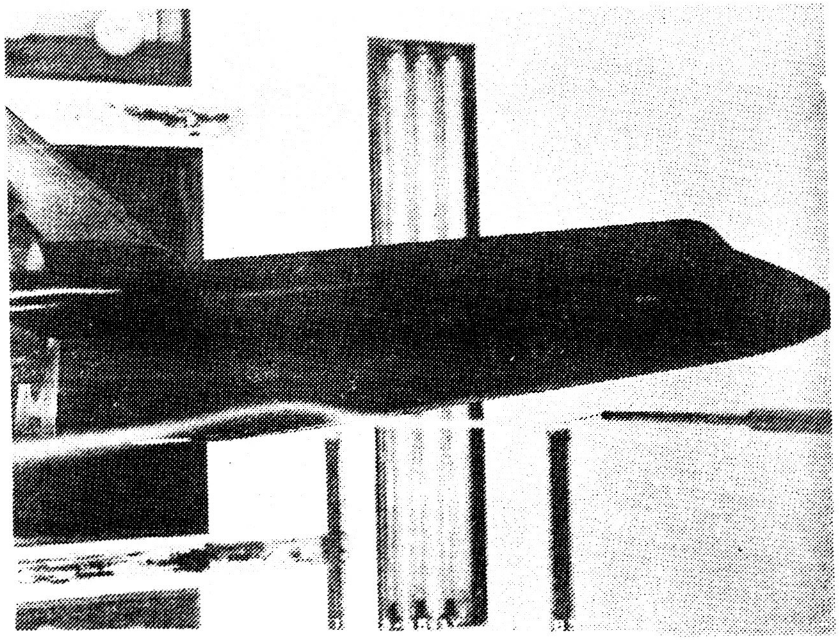
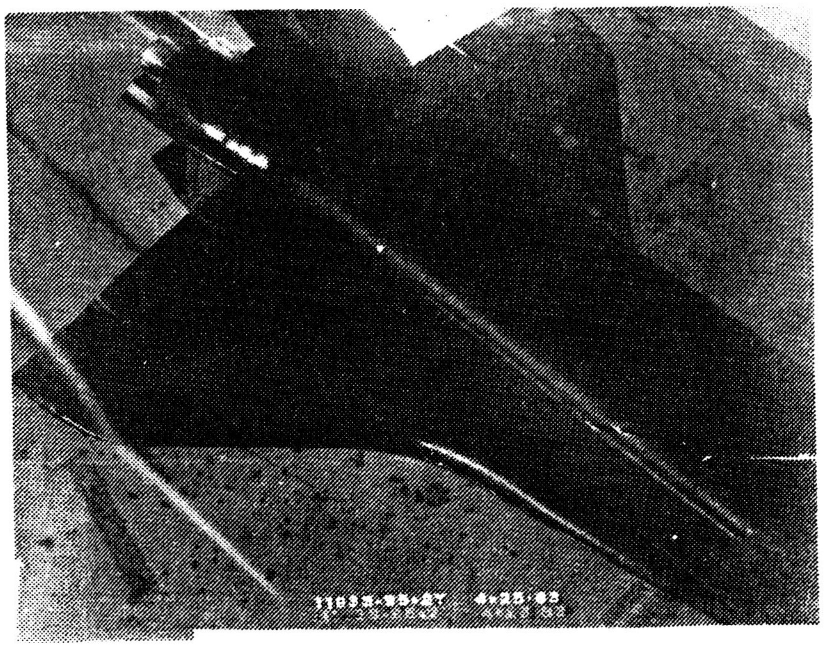
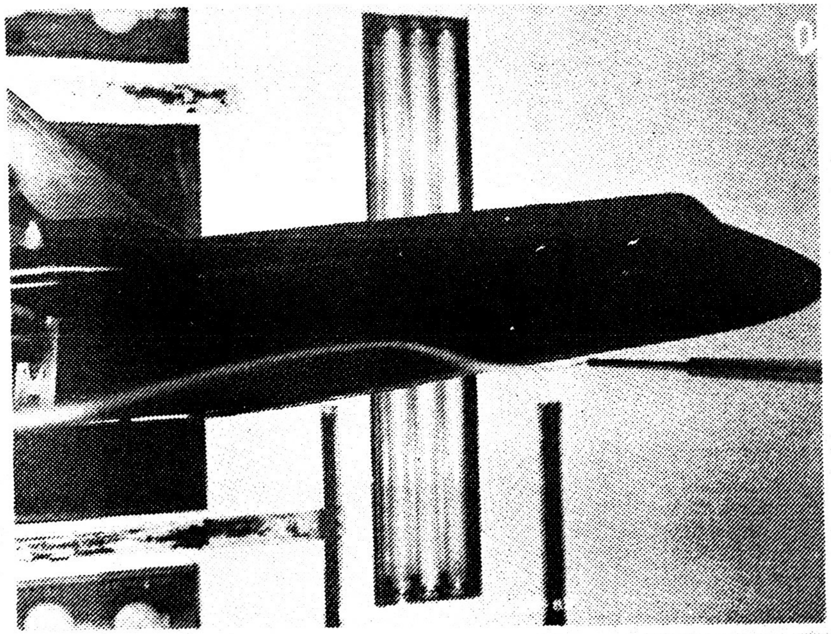


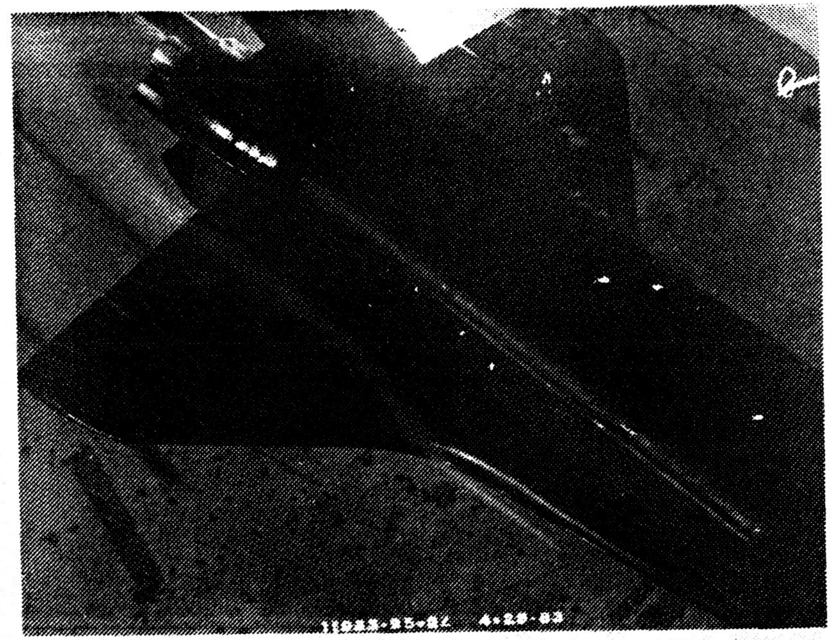


Angle of Attack = 0 Degrees

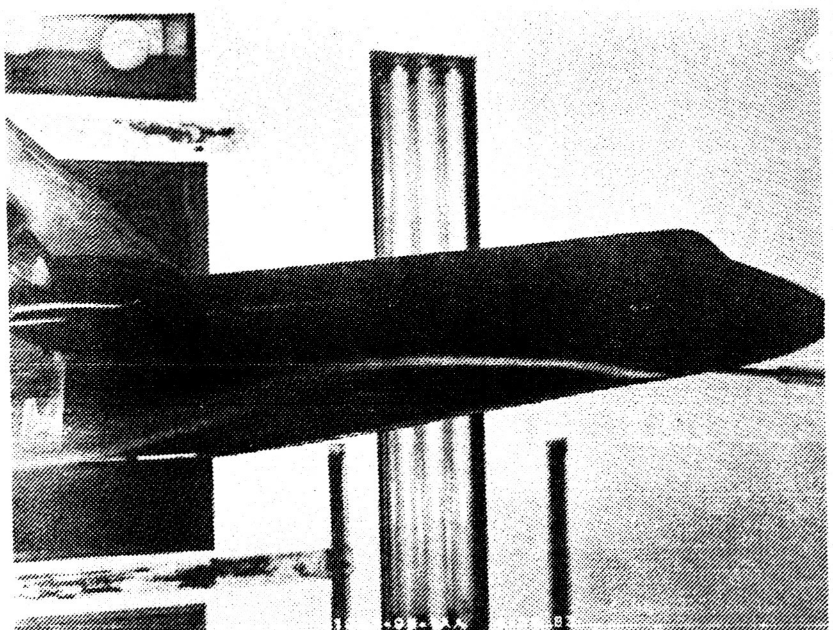


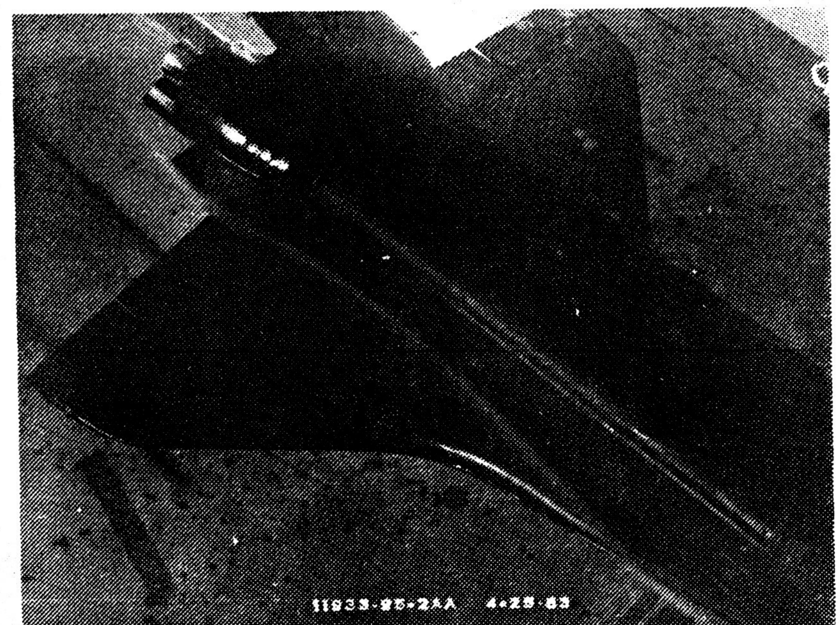




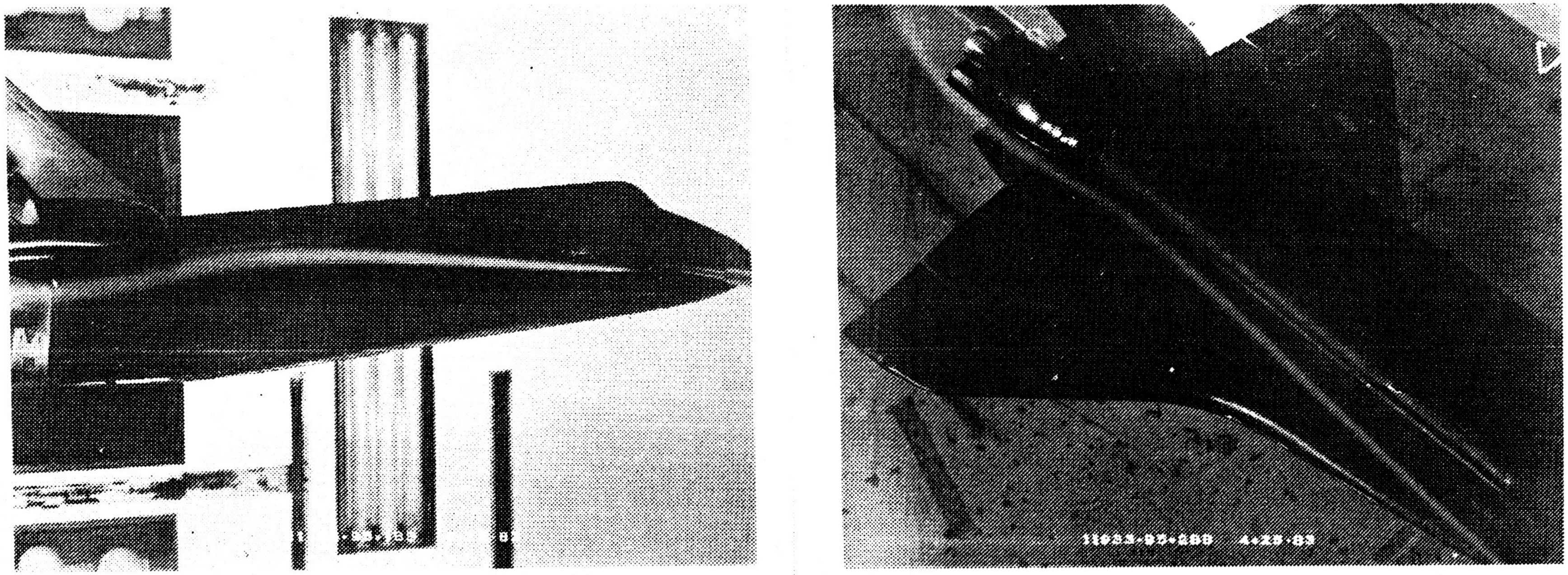


Angle of Attack = 5 Degrees

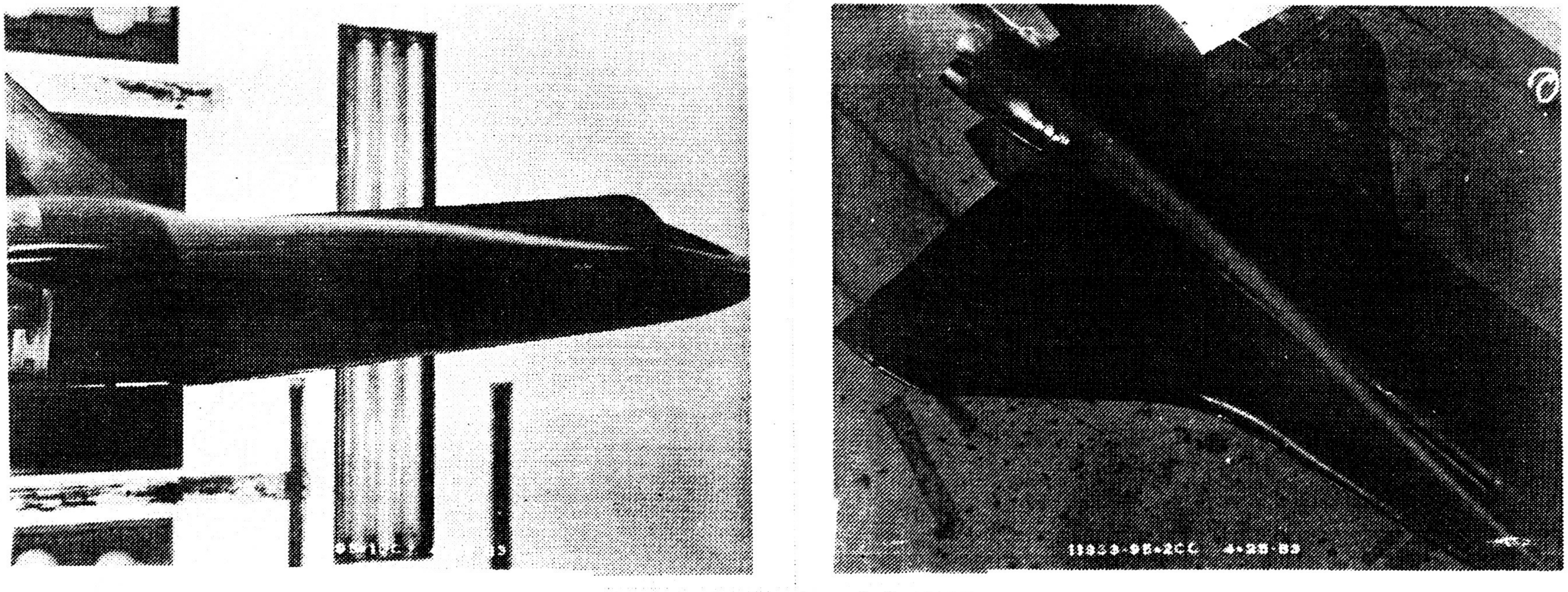




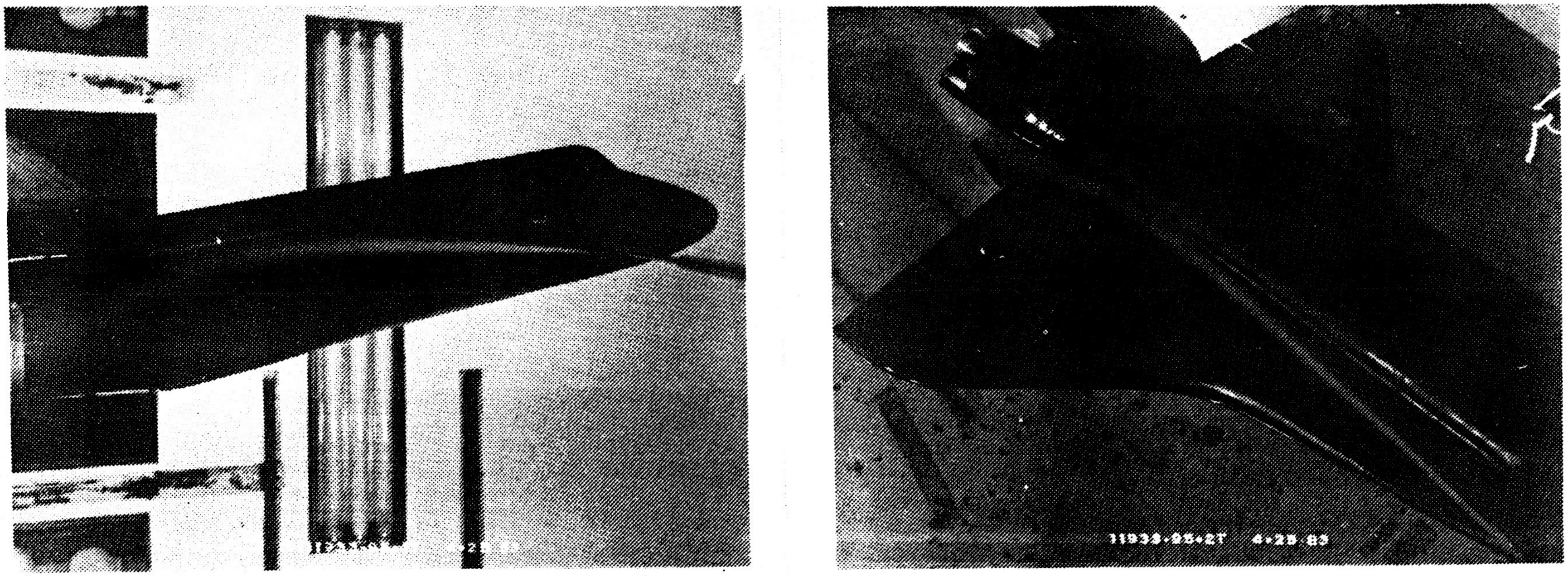
Angle of Attack = 5 Degrees



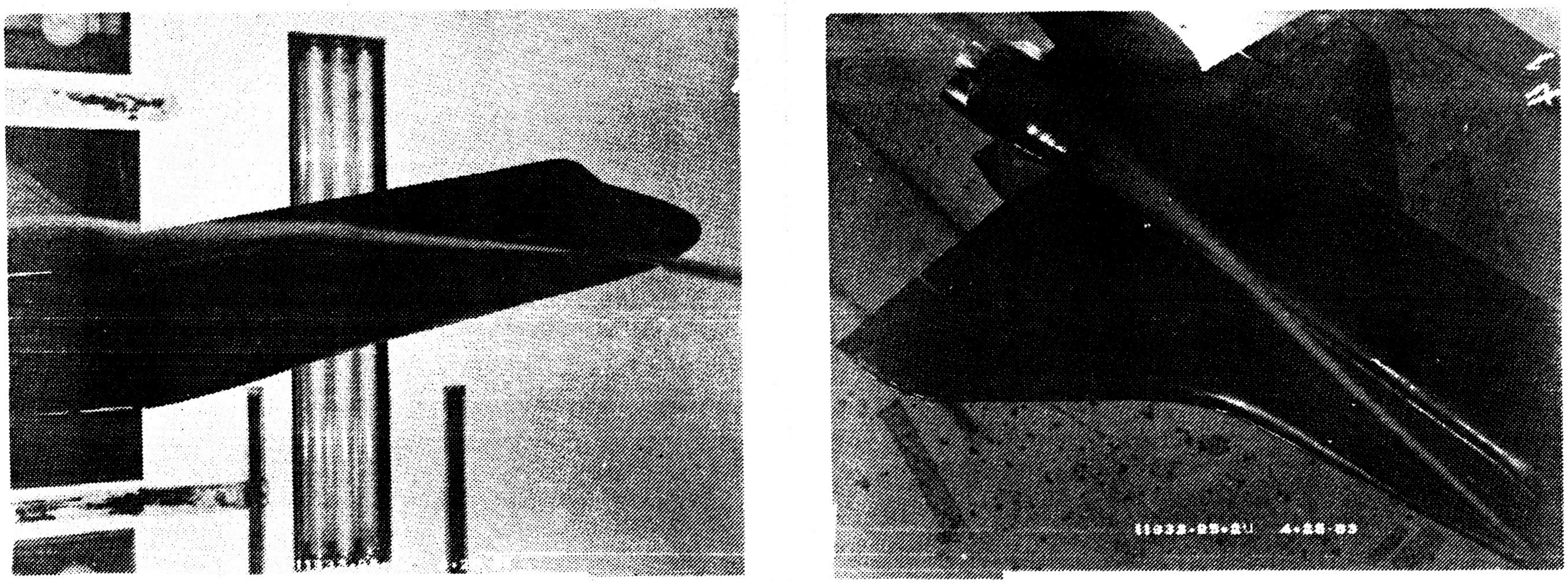
Angle of Attack = 5 Degrees



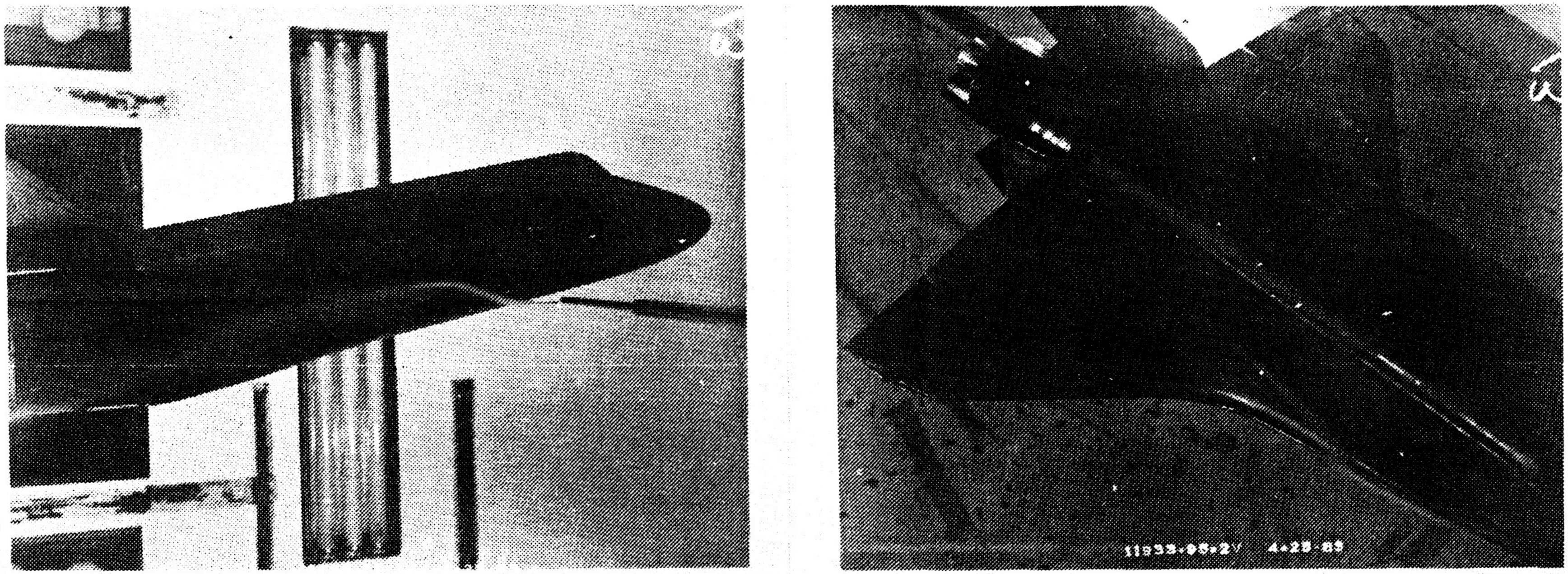
Angle of Attack = 5 Degrees



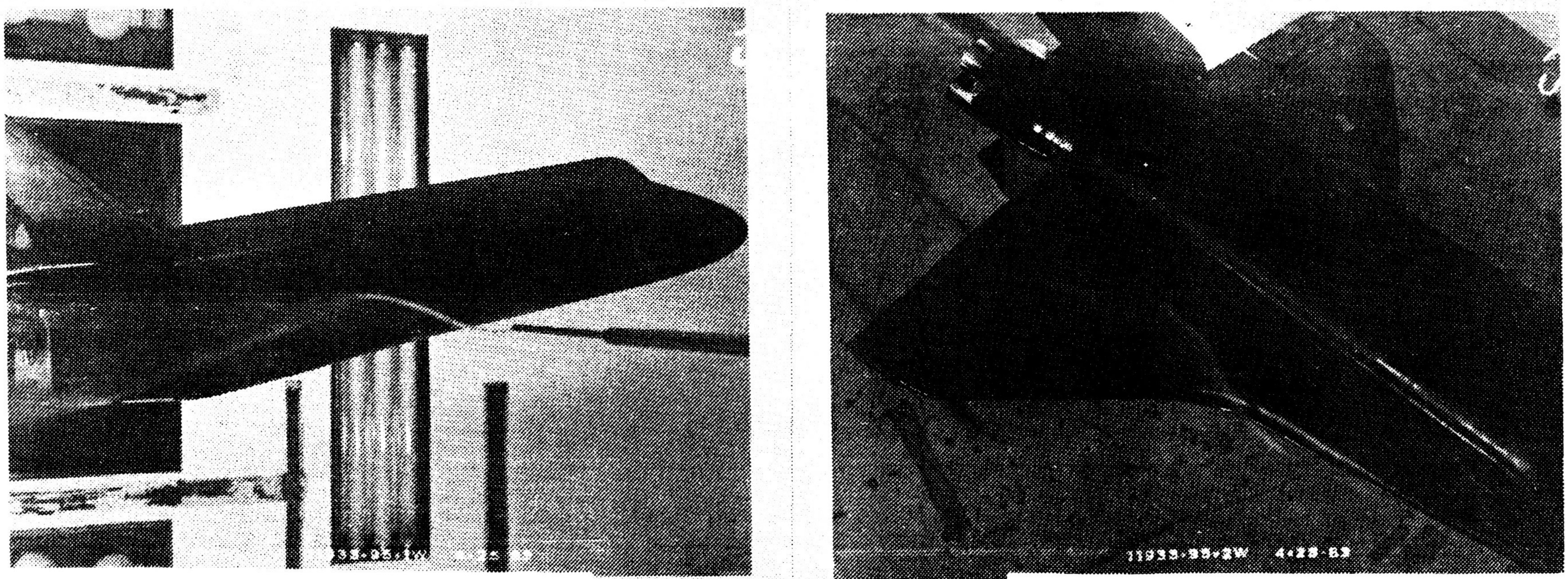
Angle of Attack = 10 Degrees



Angle of Attack = 10 Degrees

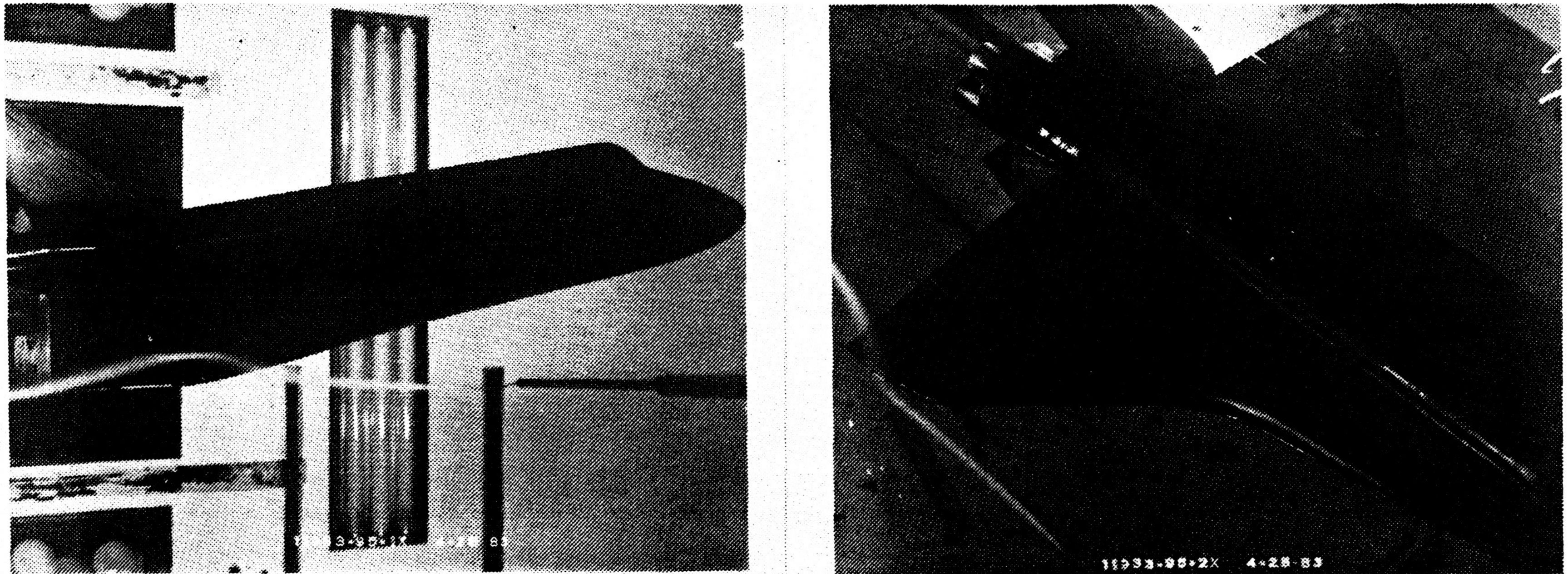


Angle of Attack = 10 Degrees

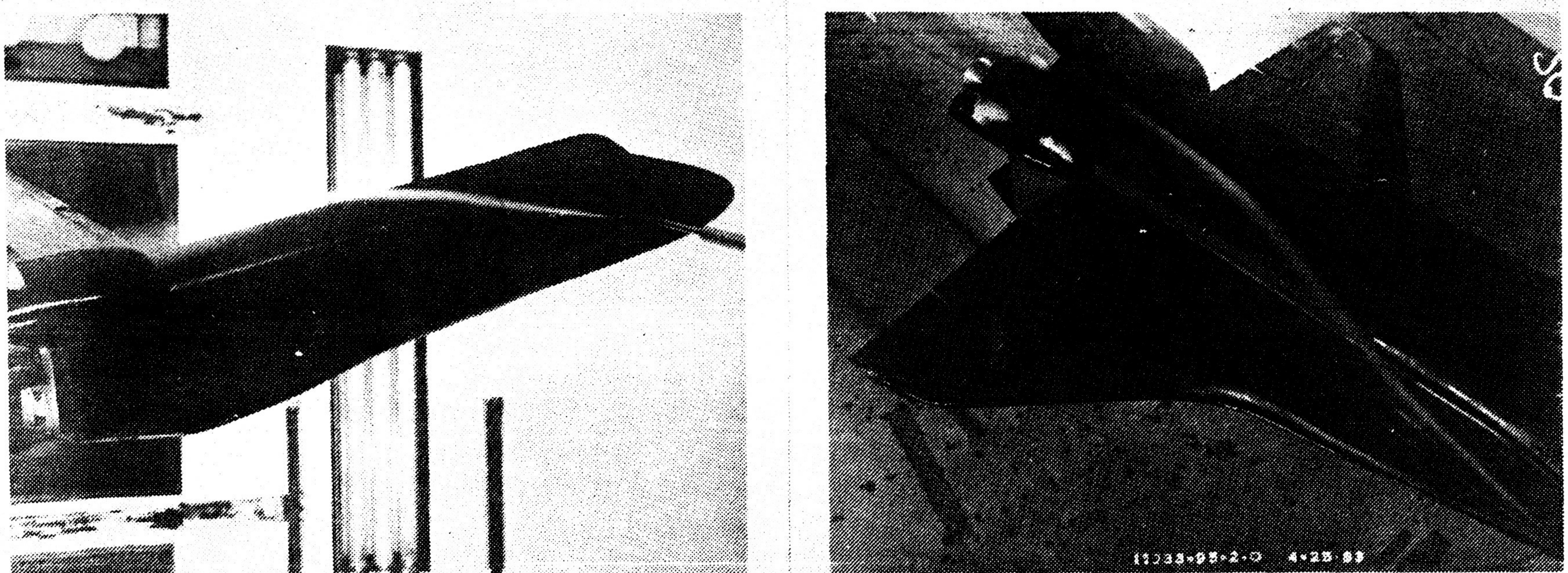


Angle of Attack = 10 Degrees

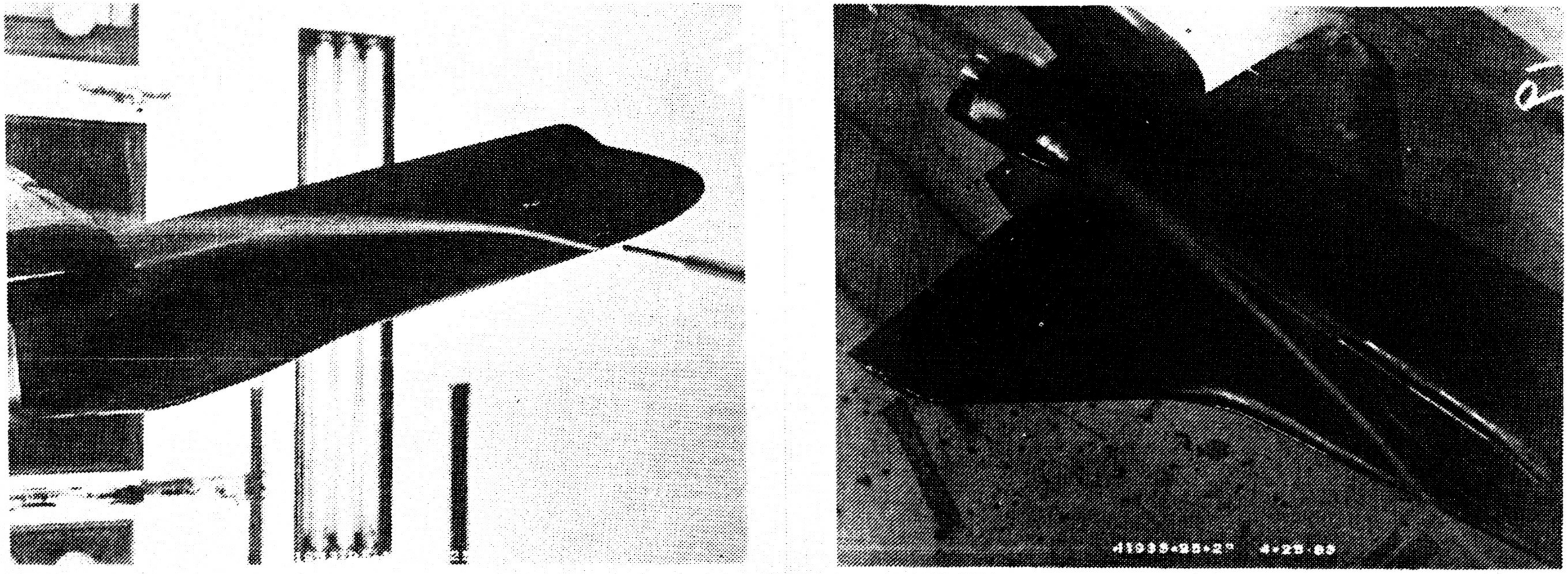
87



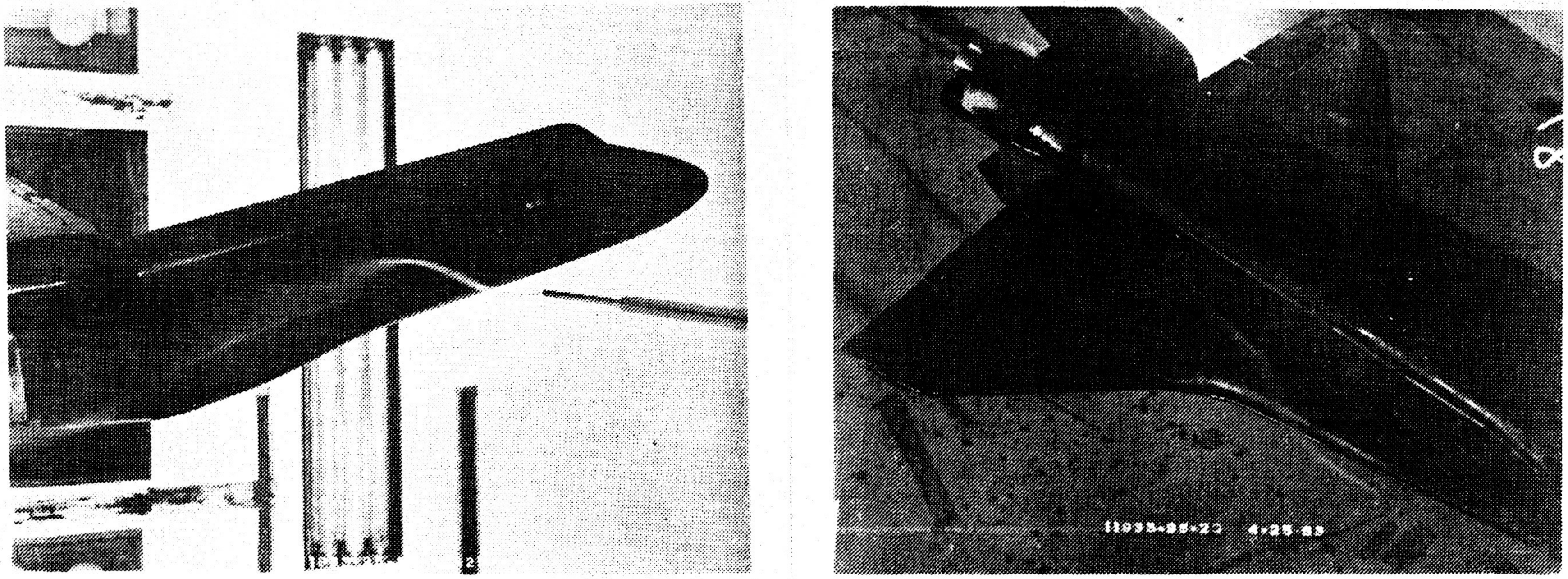
Angle of Attack = 10 Degrees



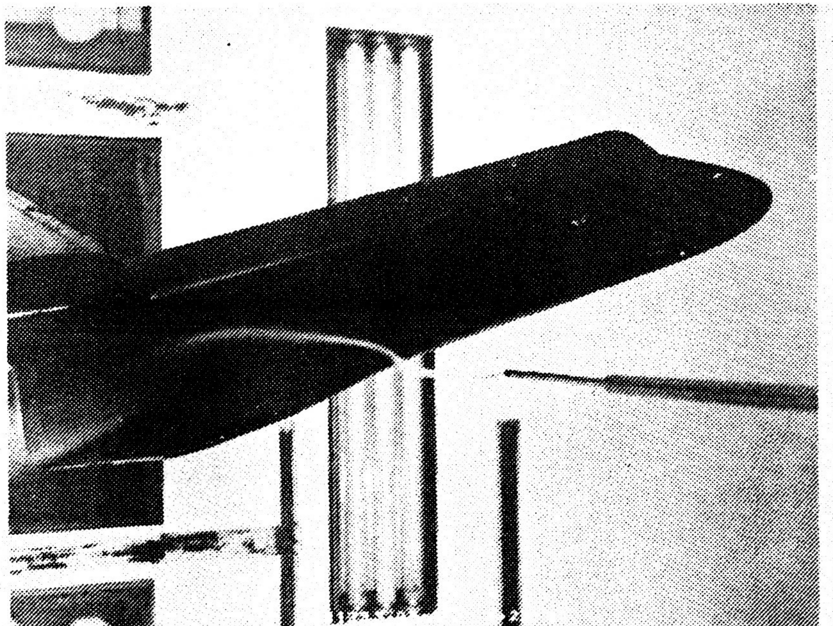
Angle of Attack = 15 Degrees

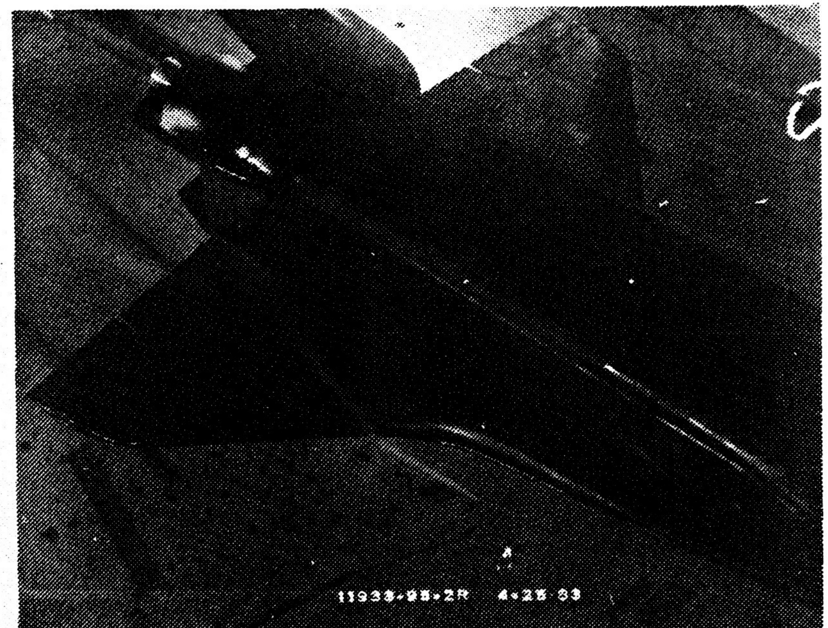


Angle of Attack = 15 Degrees

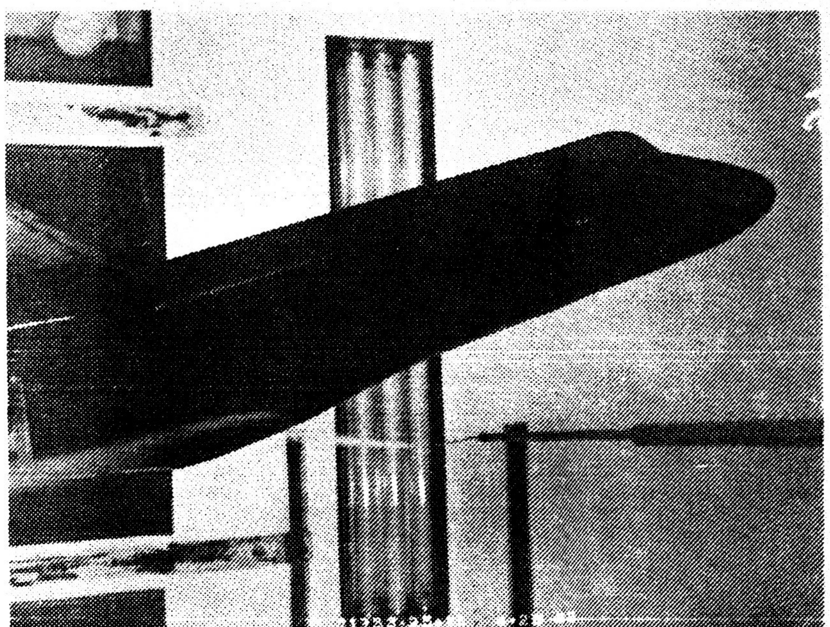


Angle of Attack = 15 Degrees

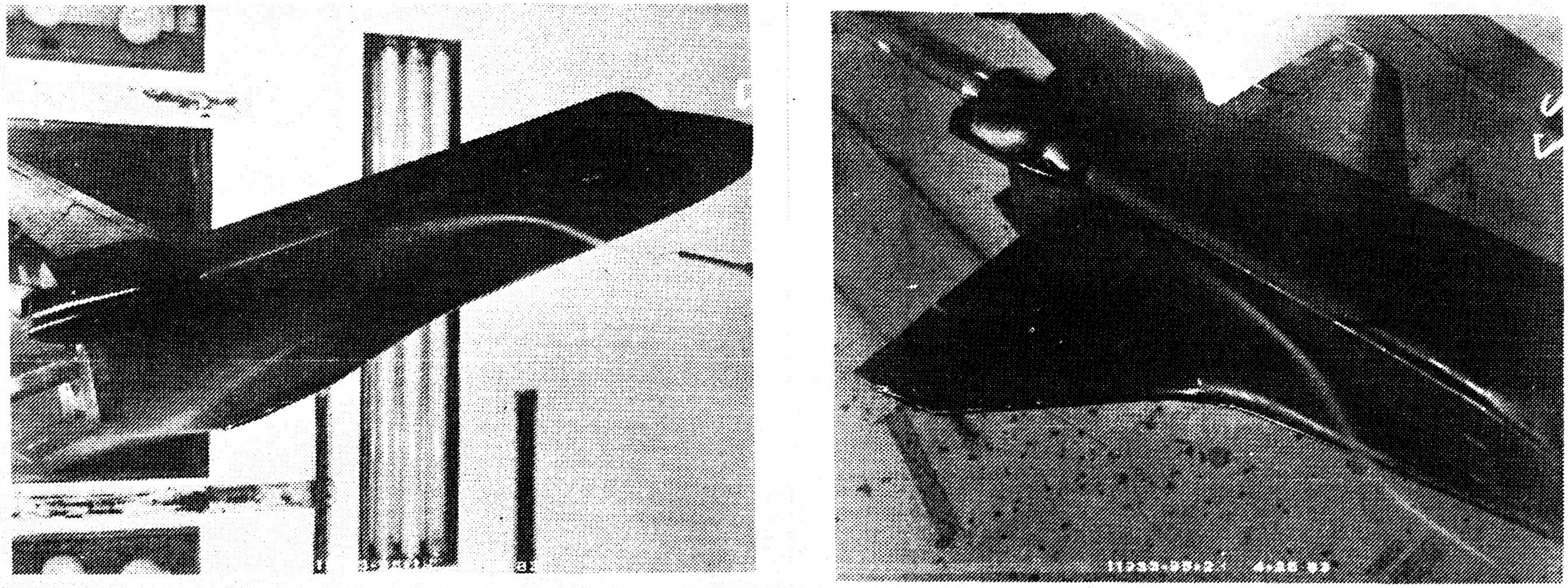




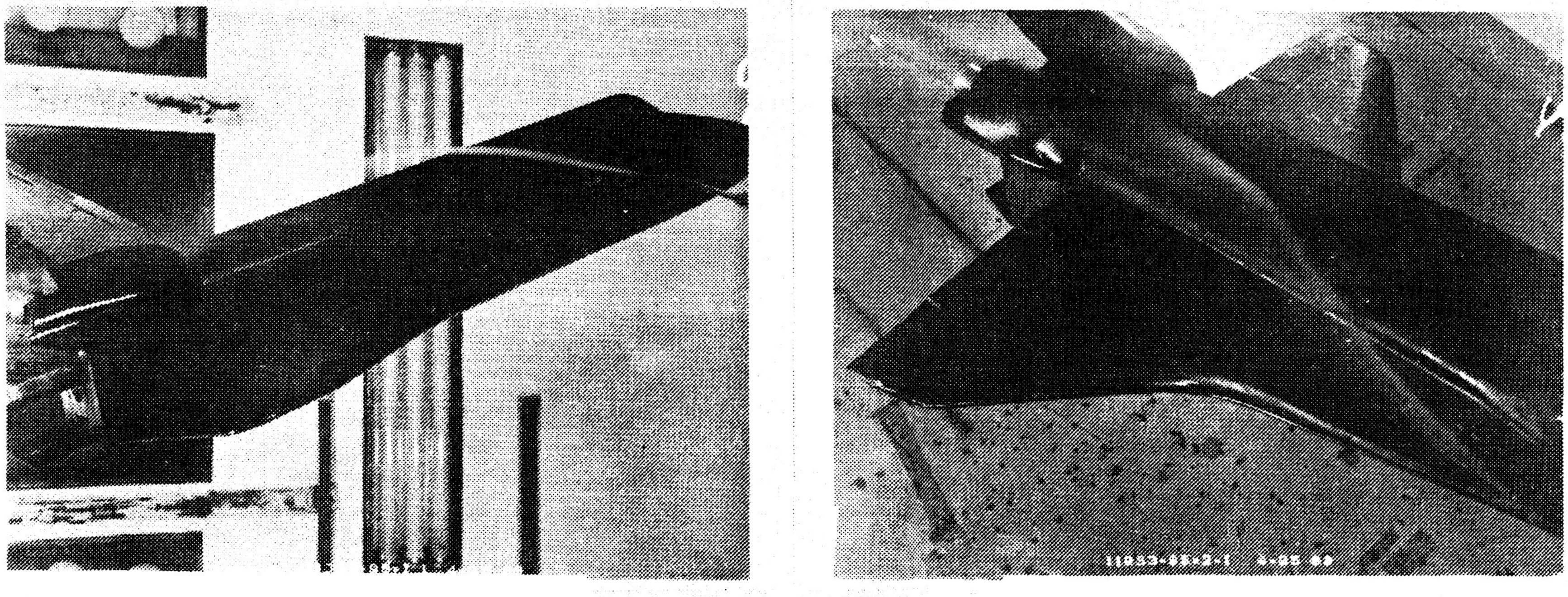
Angle of Attack = 15 Degrees



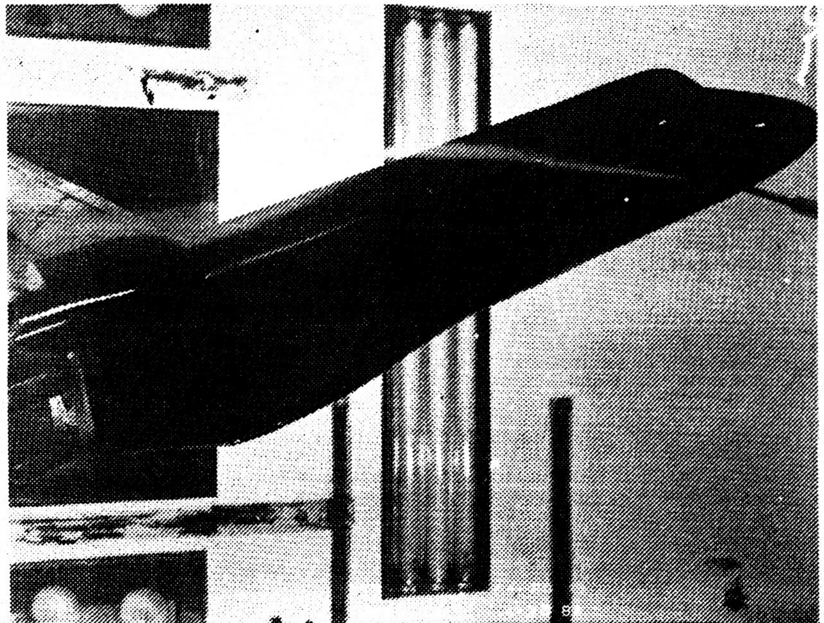
Angle of Attack = 15 Degrees

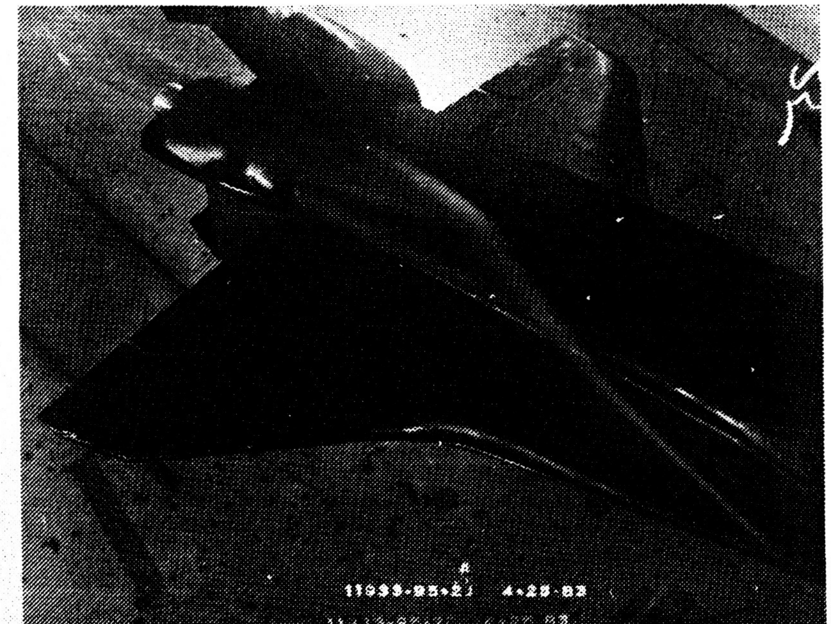


Angle of Attack = 20 Degrees

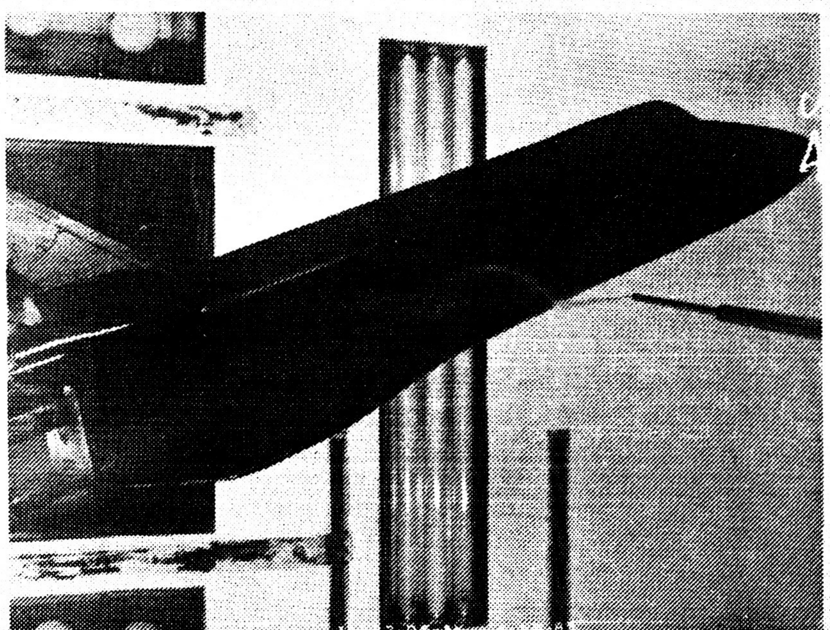


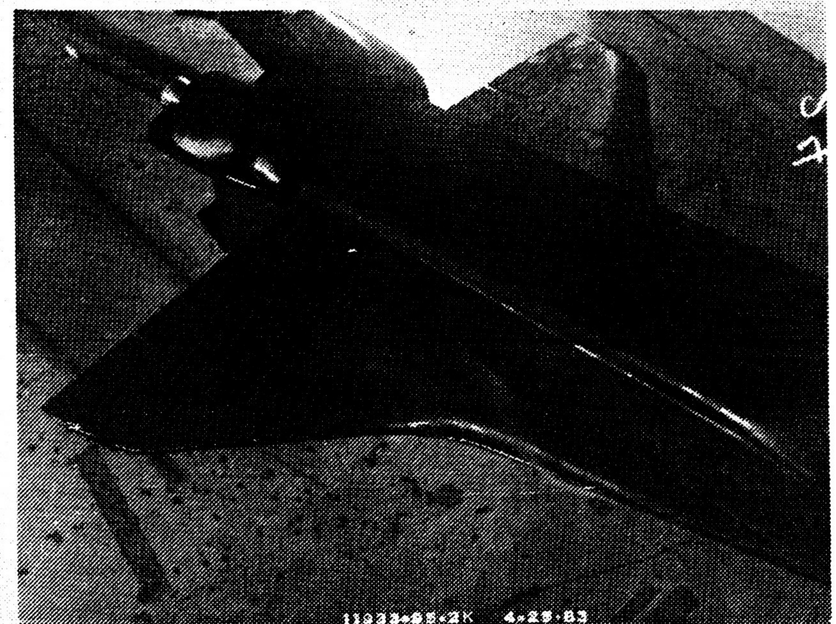
Angle of Attack = 20 Degrees



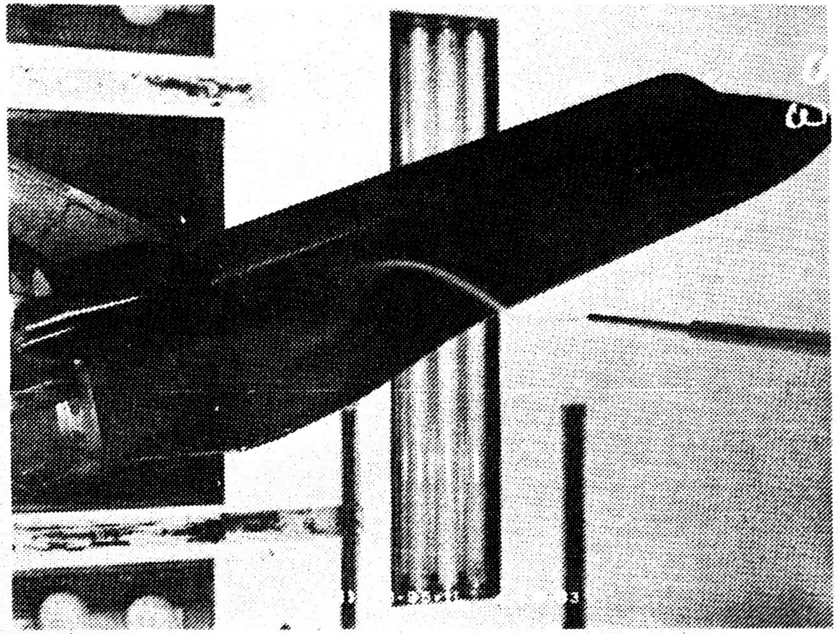


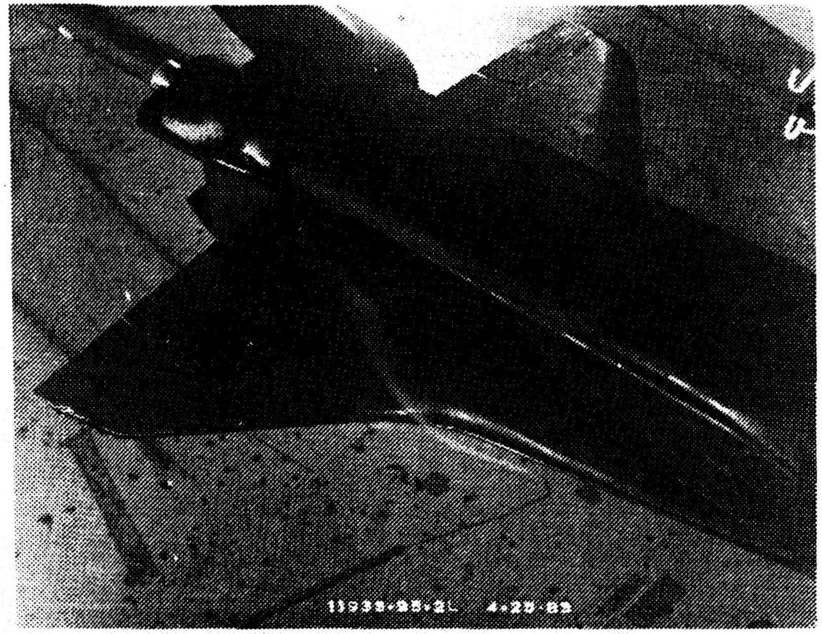
Angle of Attack = 20 Degrees



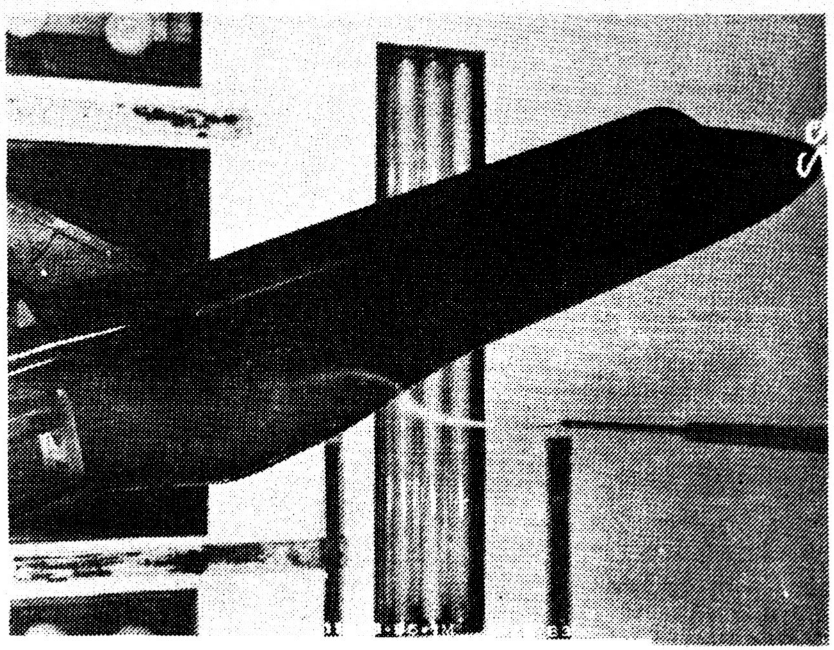


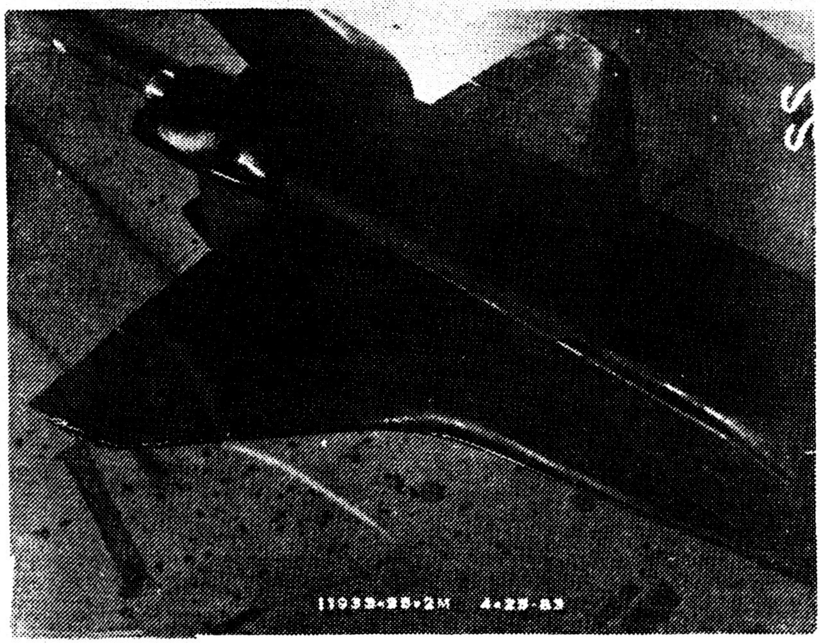
Angle of Attack = 20 Degrees

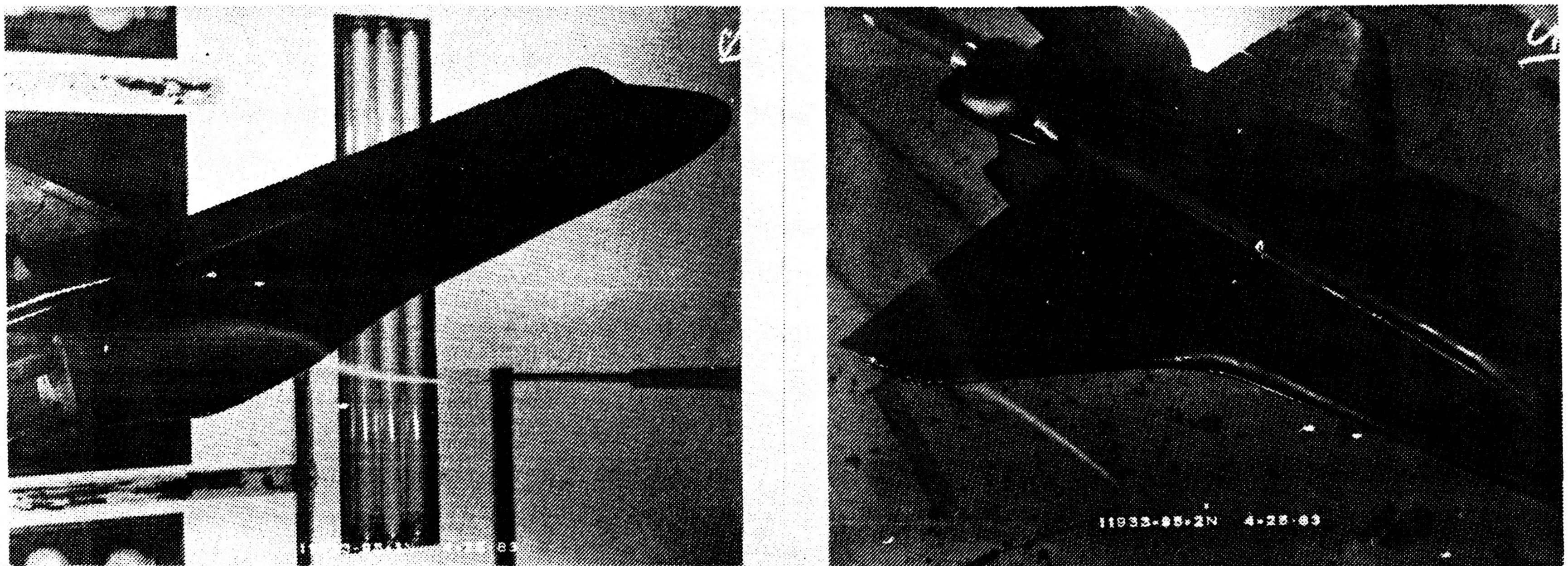




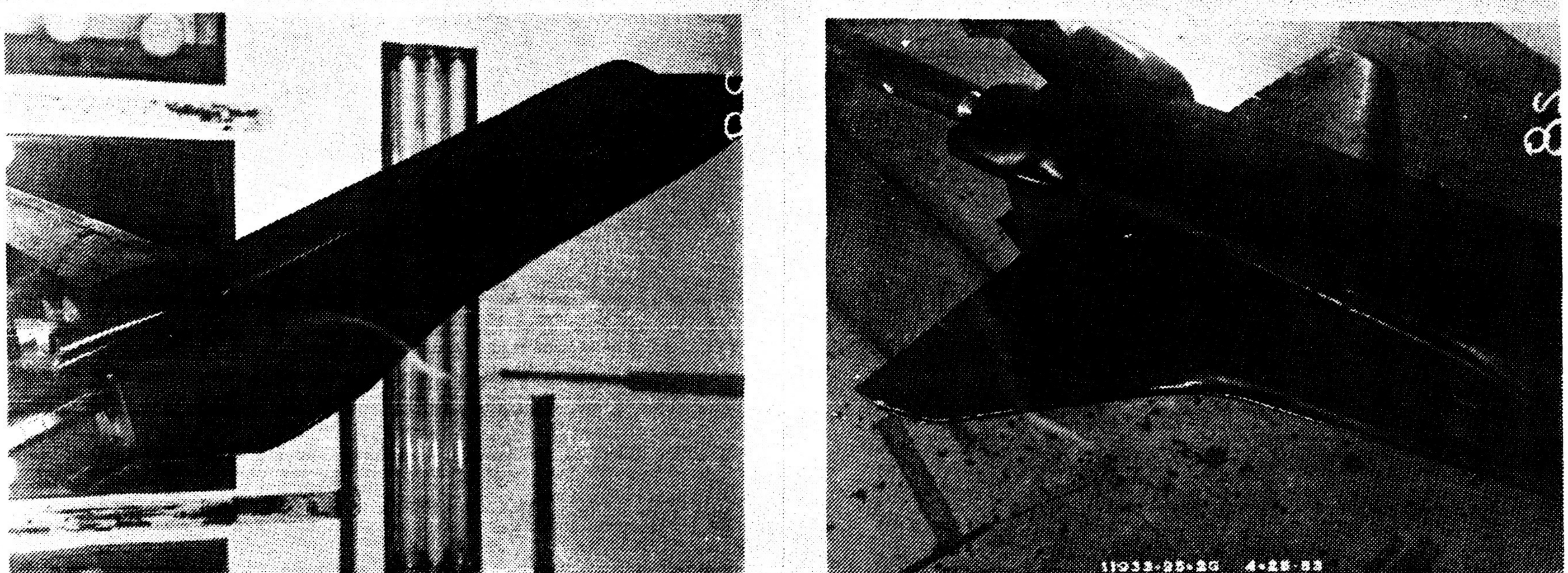
Angle of Attack = 20 Degrees



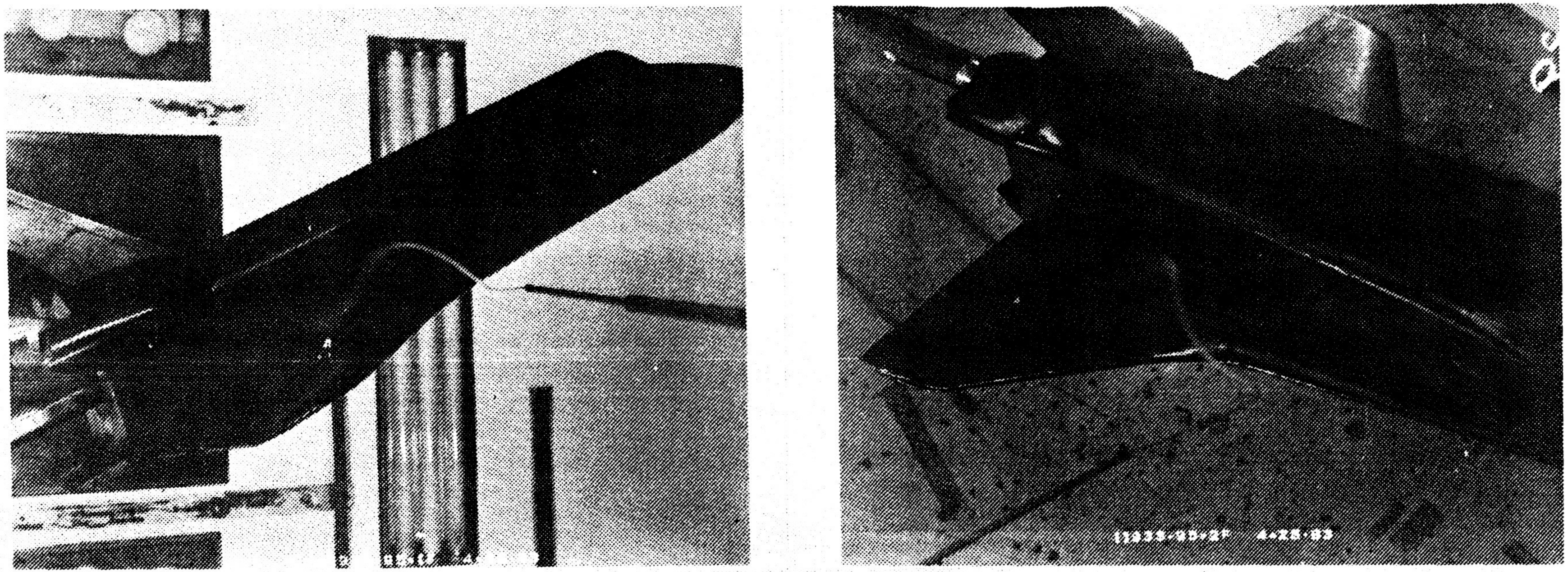




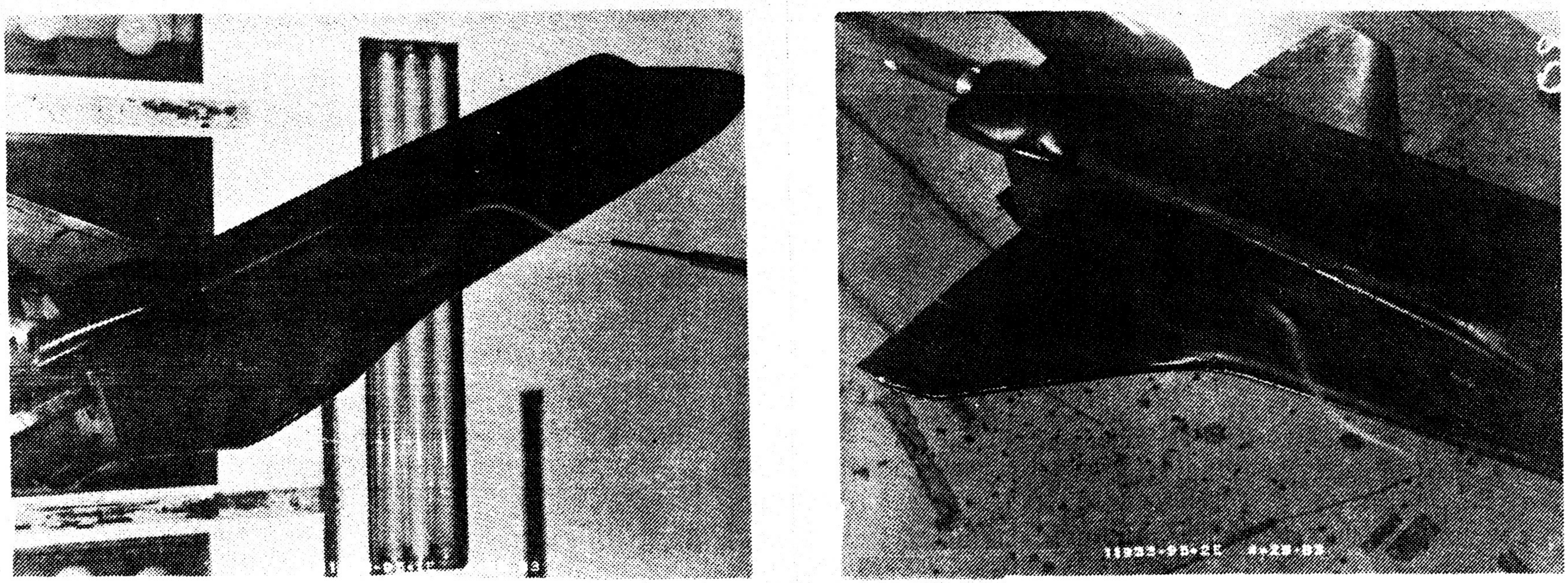
Angle of Attack = 20 Degrees



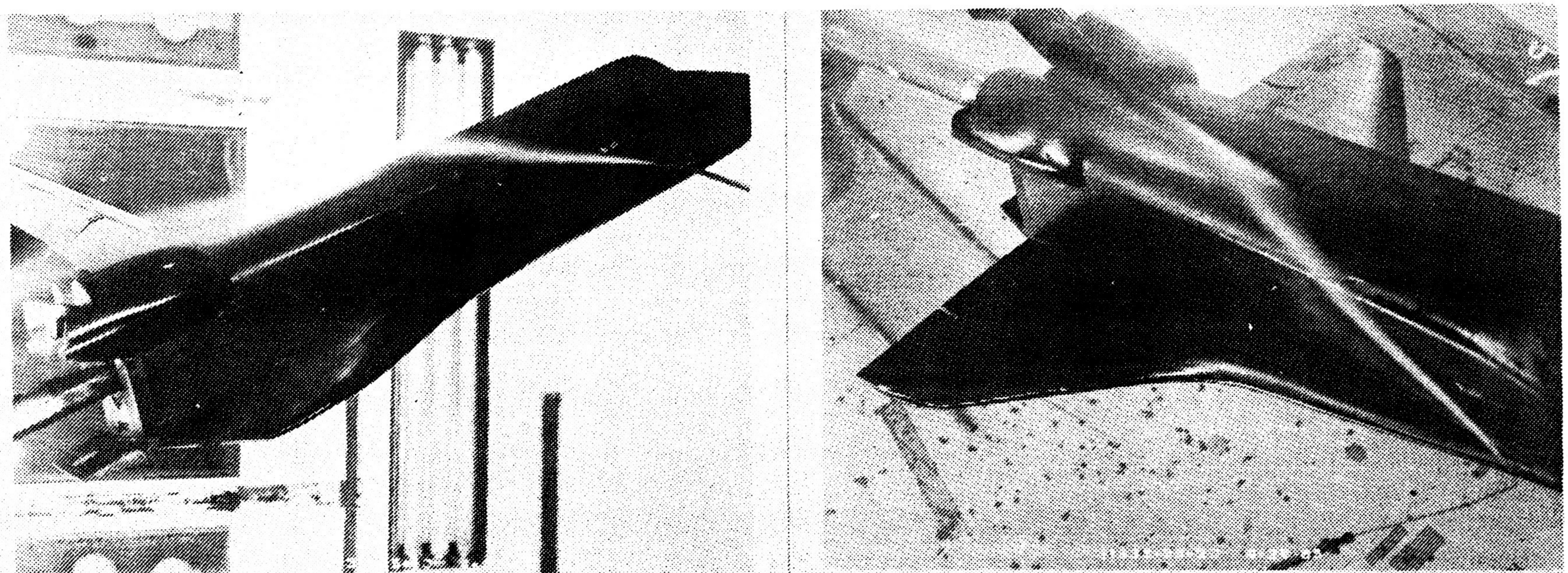
Angle of Attack = 25 Degrees



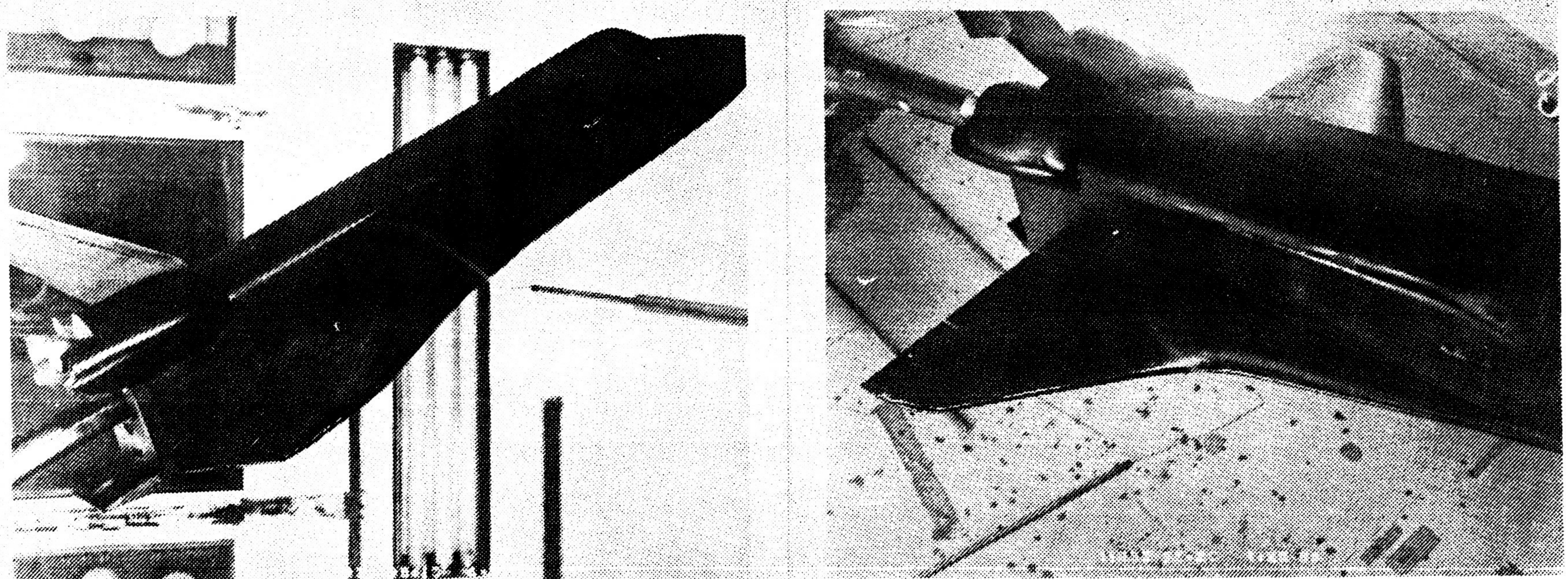
Angle of Attack = 25 Degrees



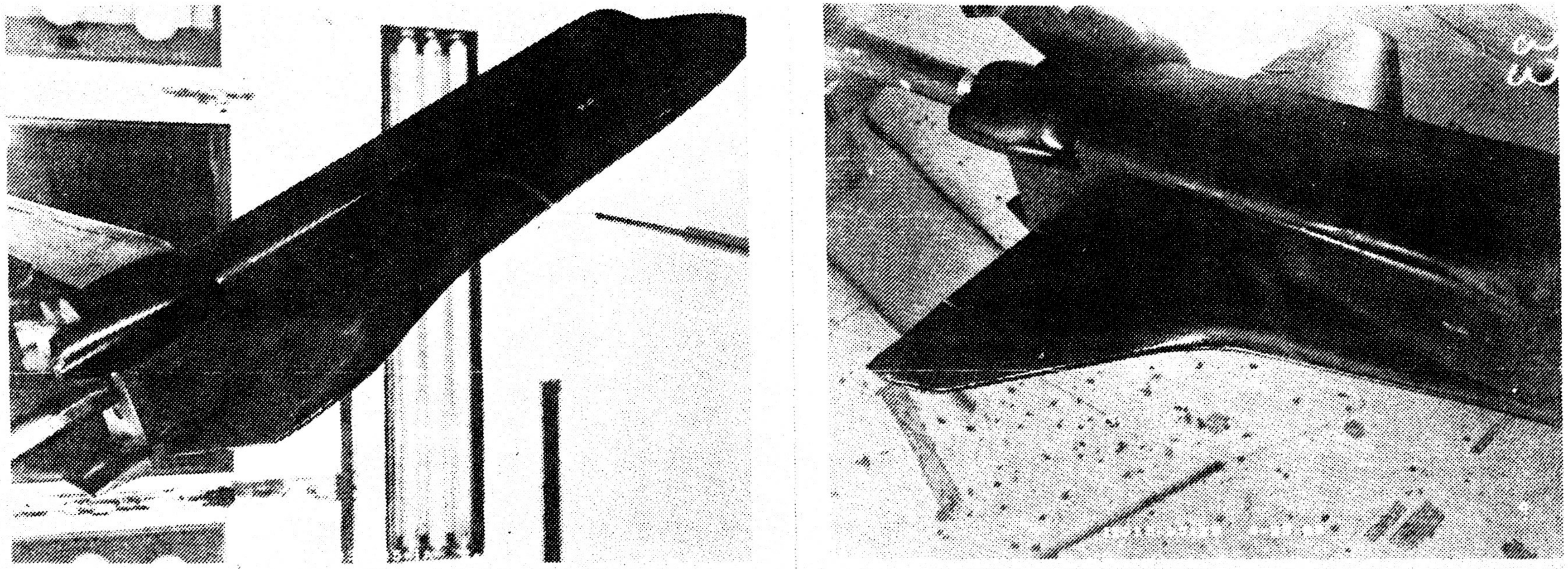
Angle of Attack = 25 Degrees



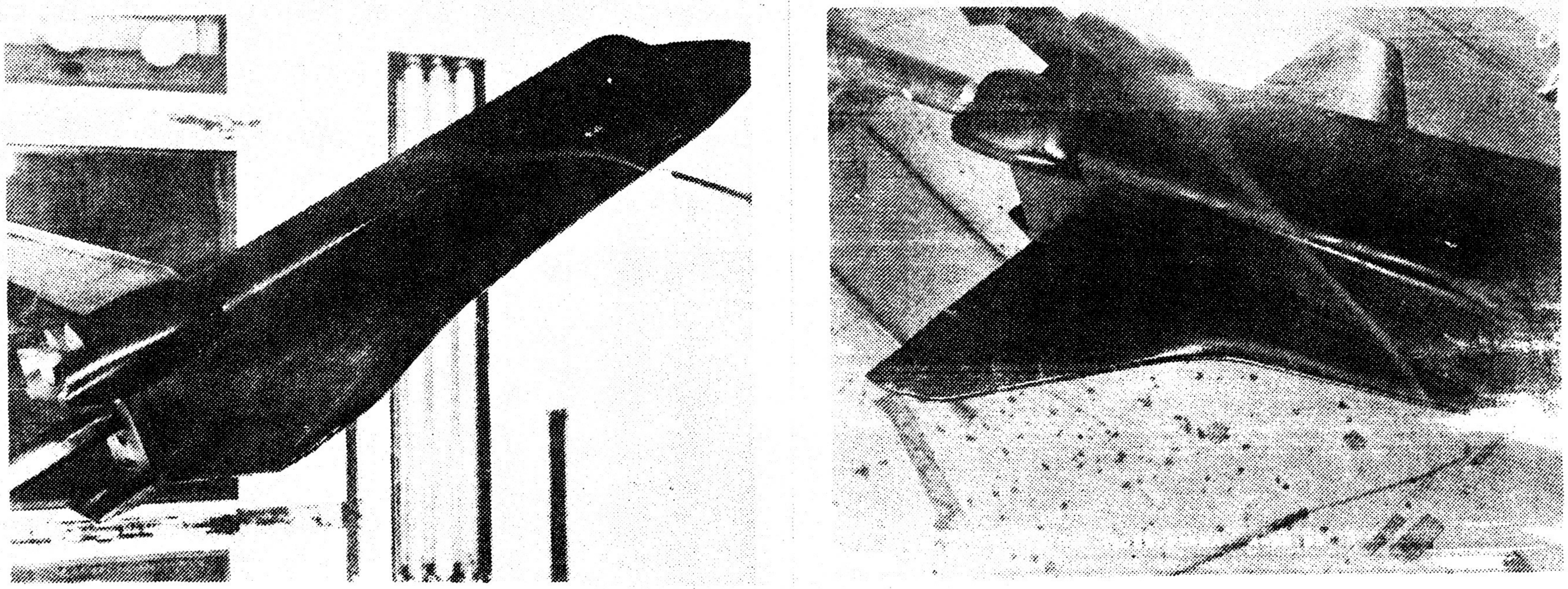
Angle of Attack = 25 Degrees



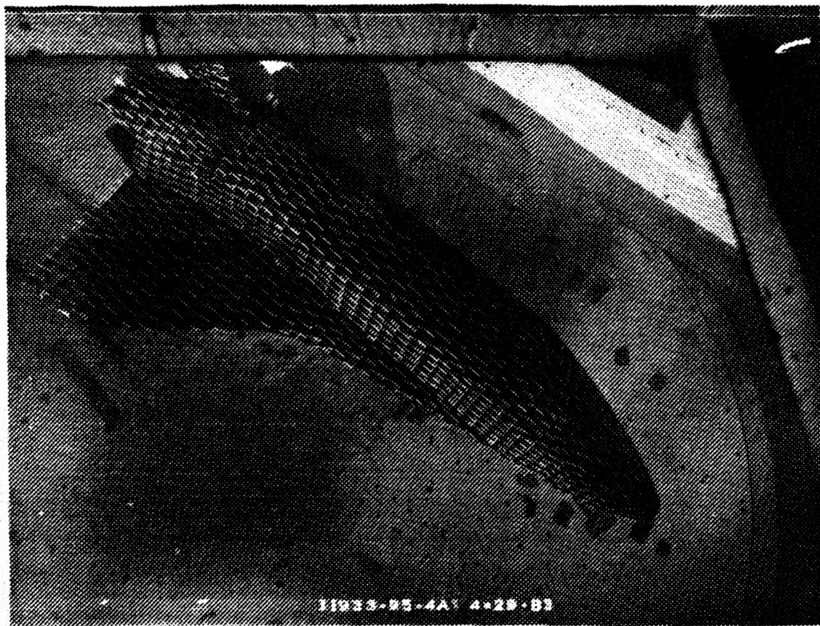
Angle of Attack = 30 Degrees



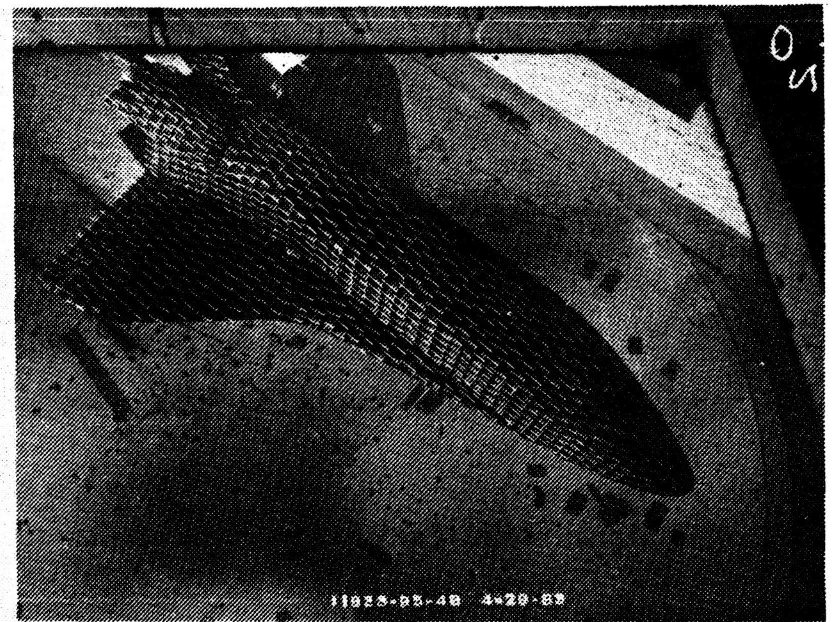
Angle of Attack = 30 Degrees, Dynamic Pressure = 10 psf



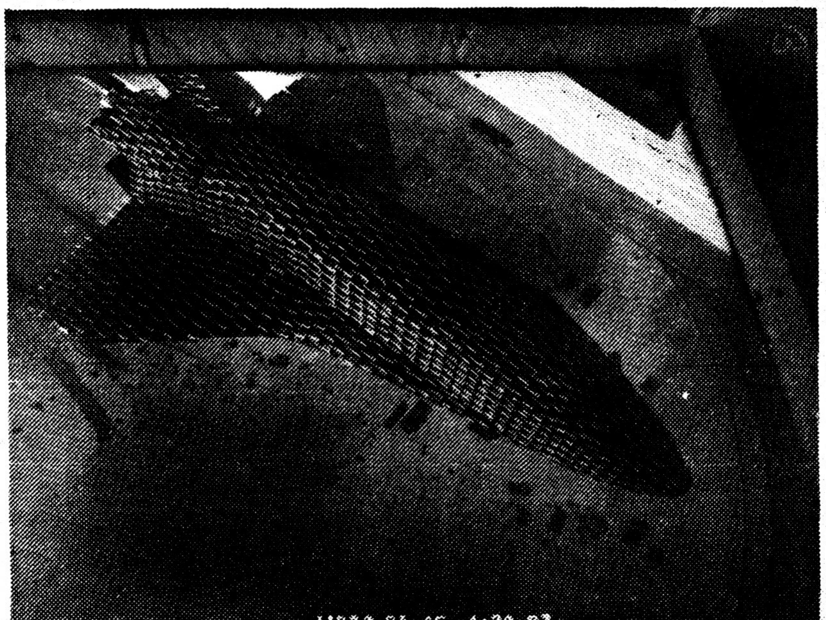
Angle of Attack = 30 Degrees



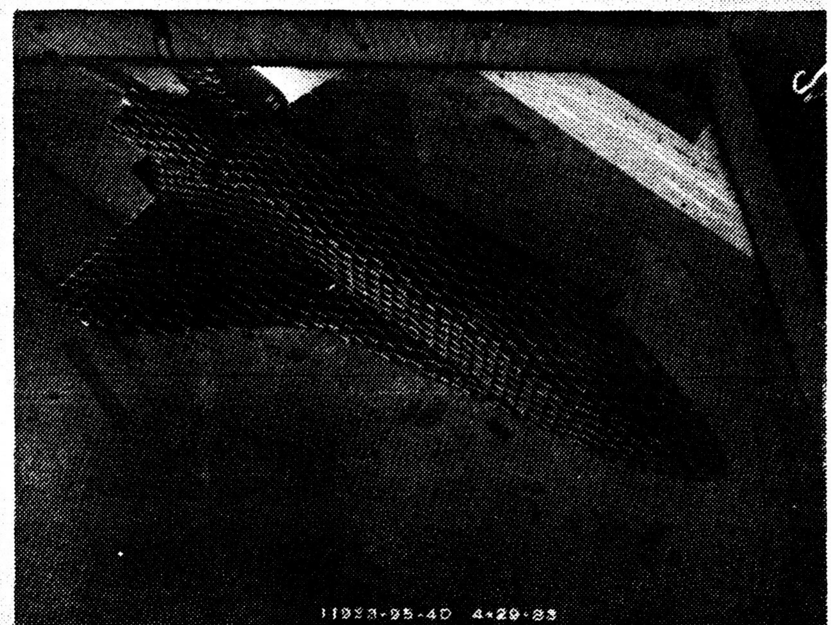
Angle of Attack = -5 Degrees



Angle of Attack = 0 Degrees

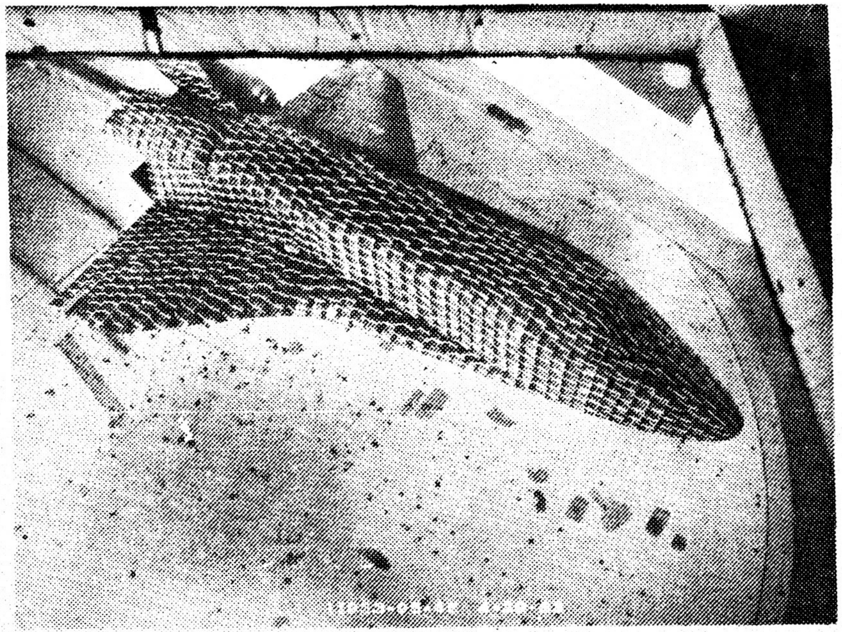


Angle of Attack = 5 Degrees

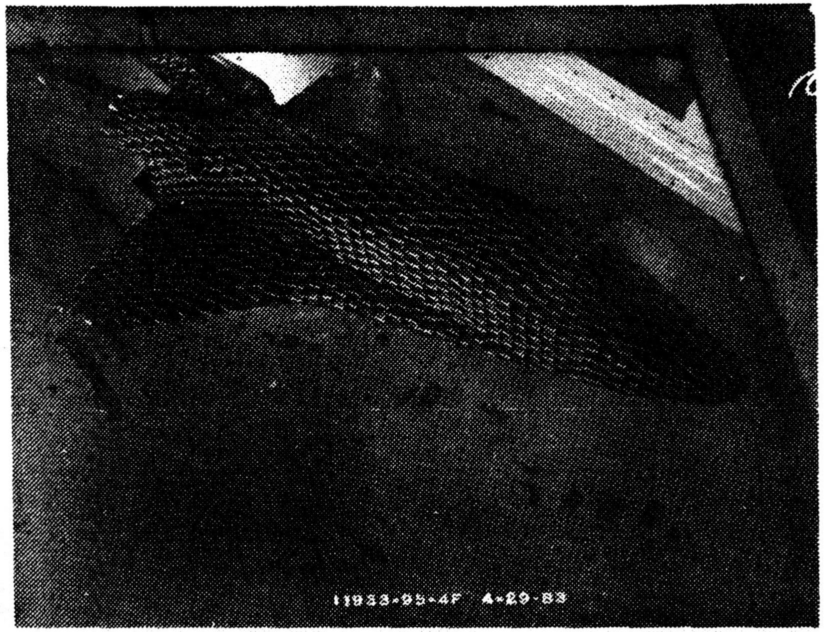


Angle of Attack = 10 Degrees

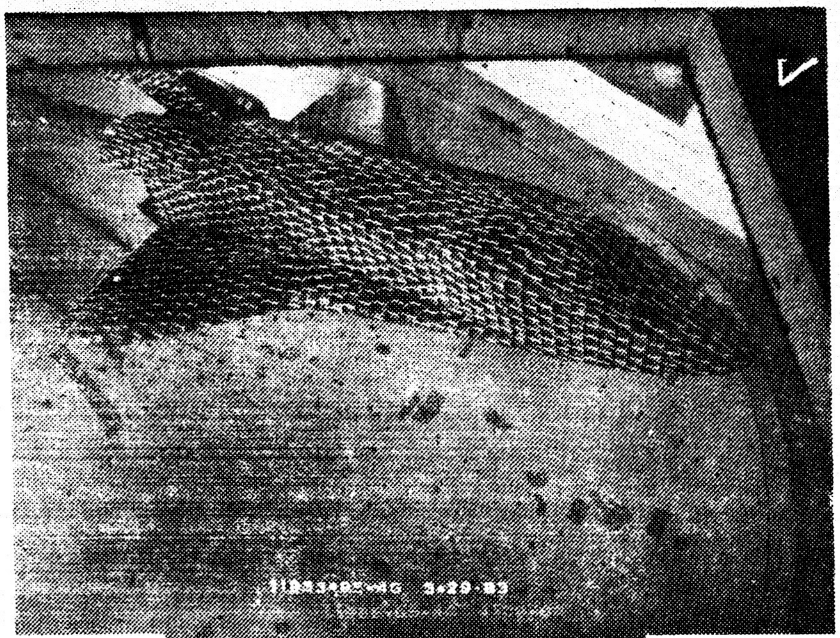
Run 7



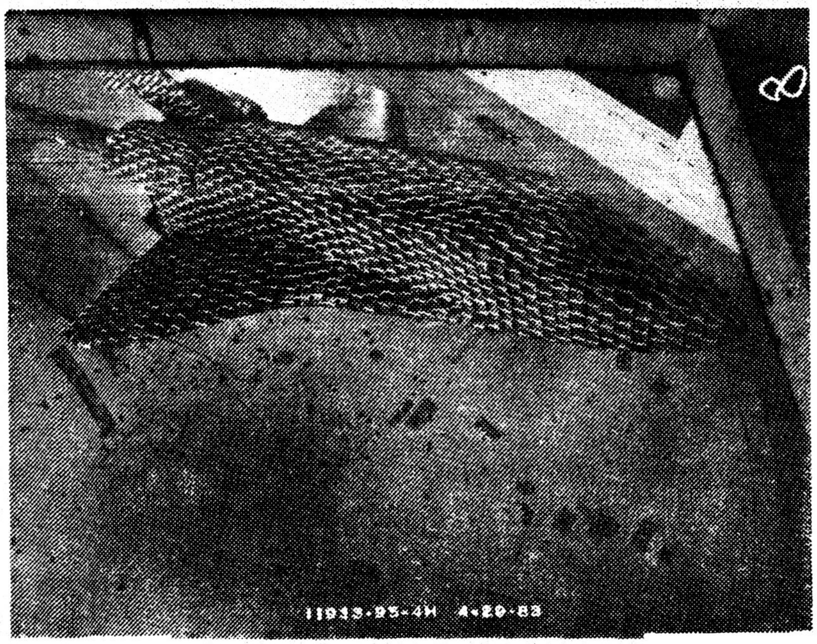
Angle of Attack = 15 Degrees



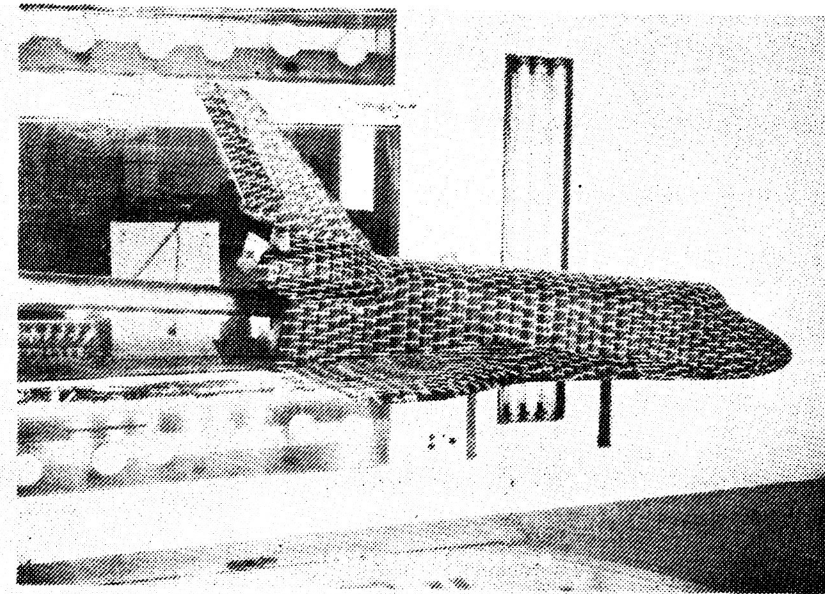
Angle of Attack = 20 Degrees



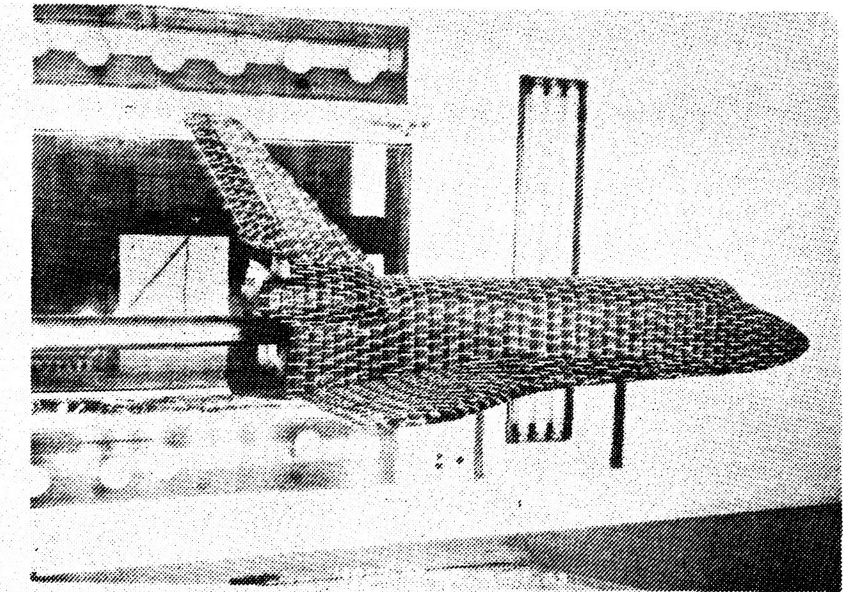
Angle of Attack = 25 Degrees



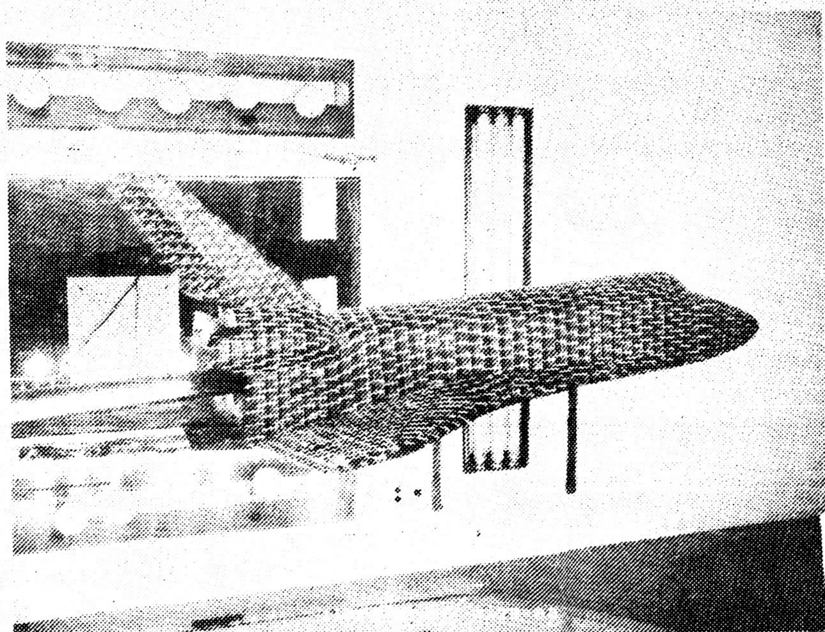
Angle of Attack = 30 Degrees



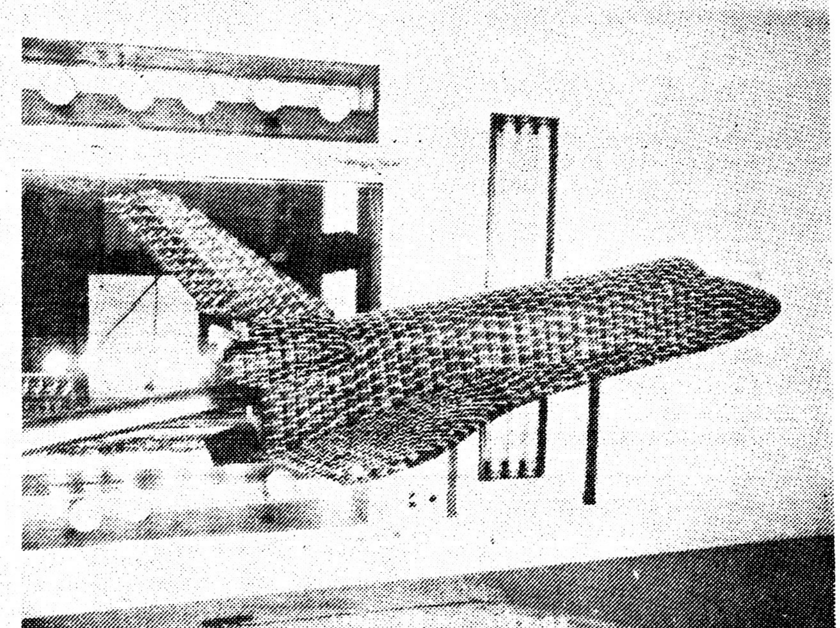
Angle of Attack = -5 Degrees



Angle of Attack = 0 Degrees

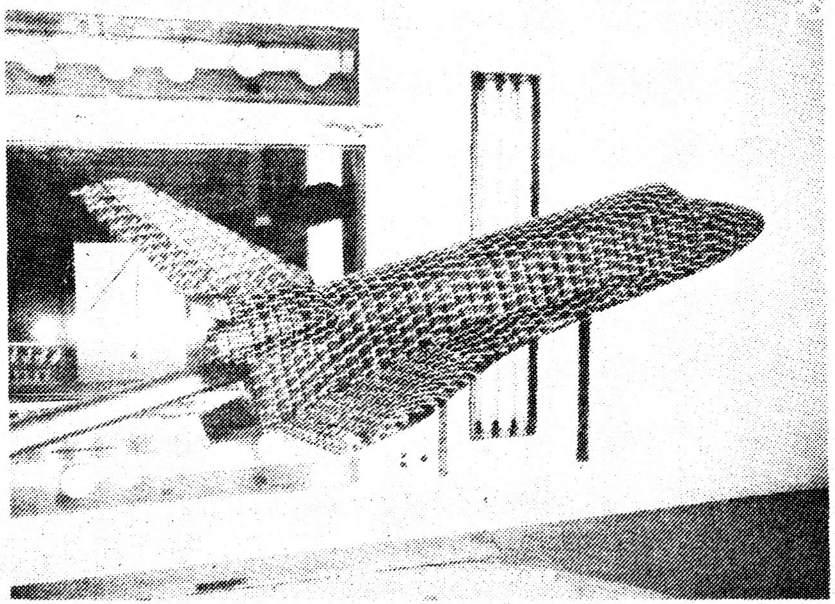


Angle of Attack = 5 Degrees

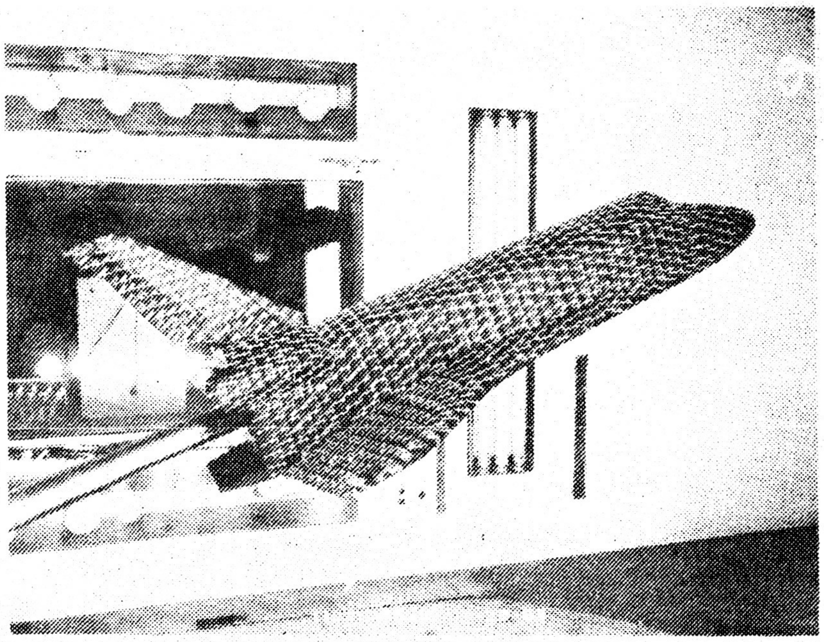


Angle of Attack = 10 Degrees

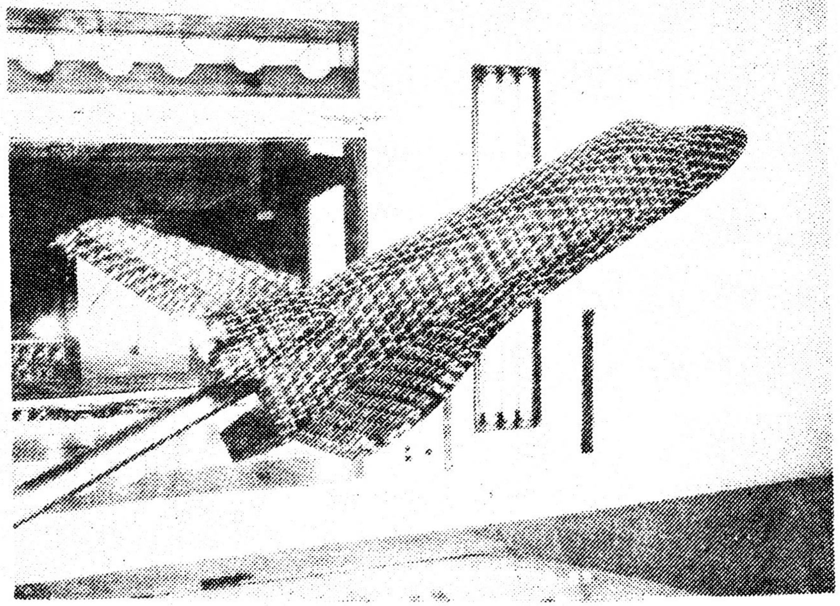
Run 8



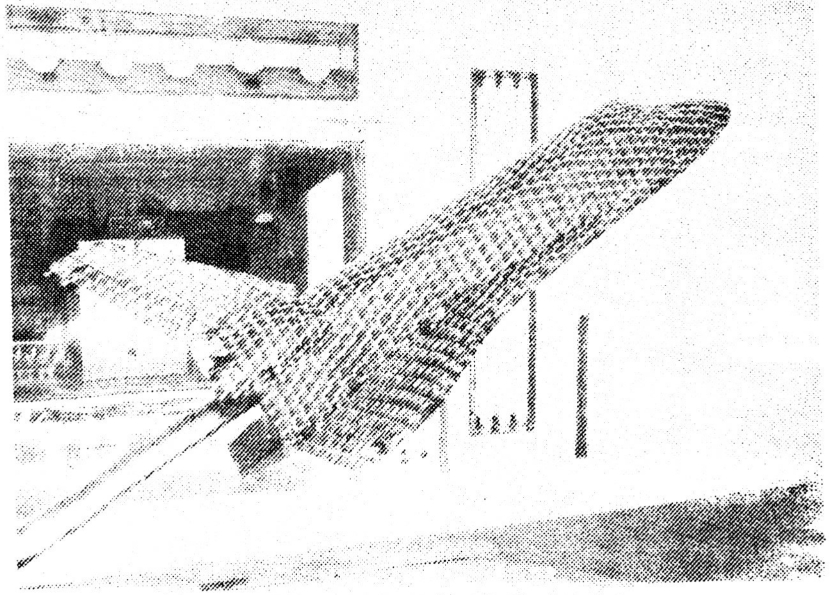
Angle of Attack = 15 Degrees



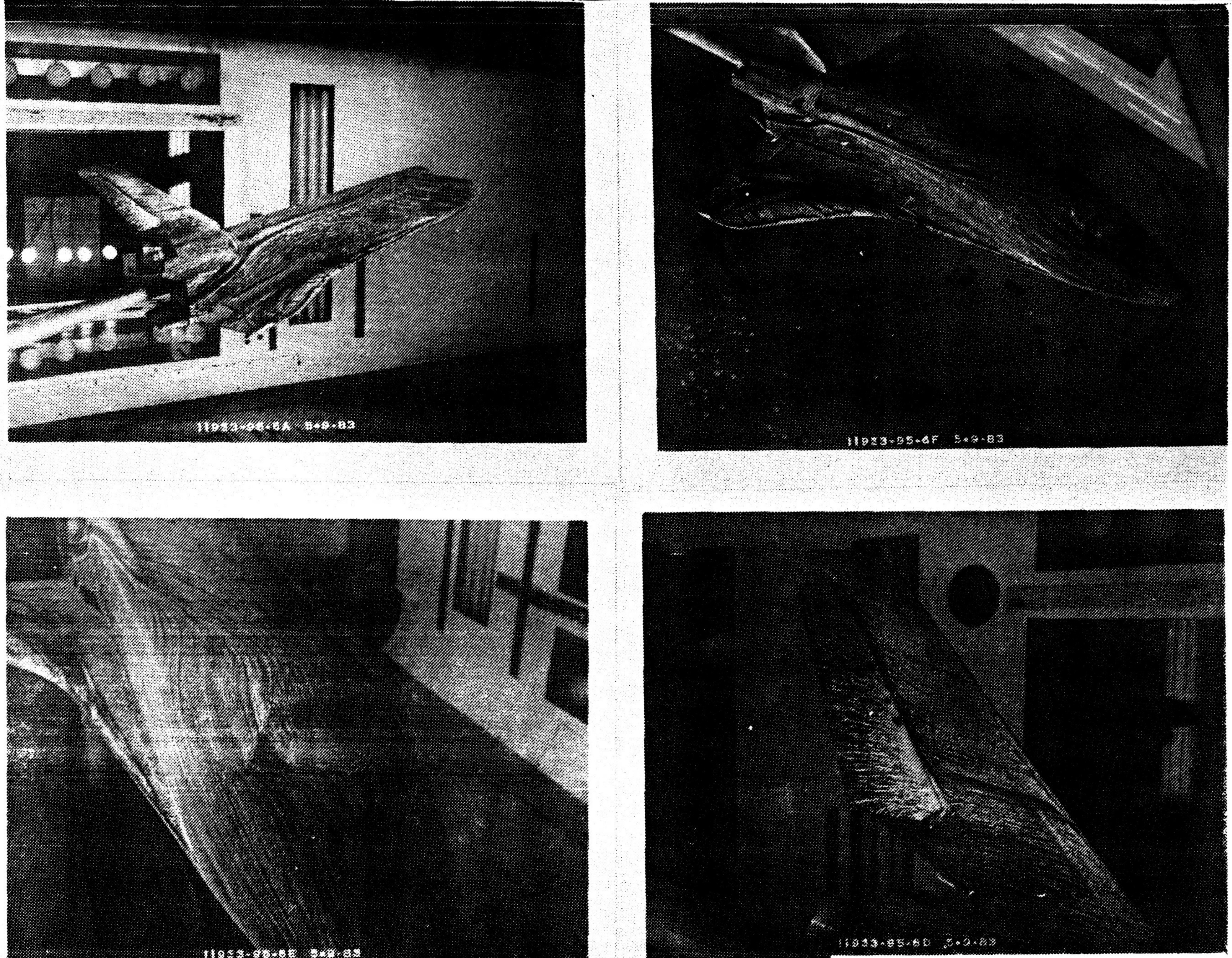
Angle of Attack = 20 Degrees



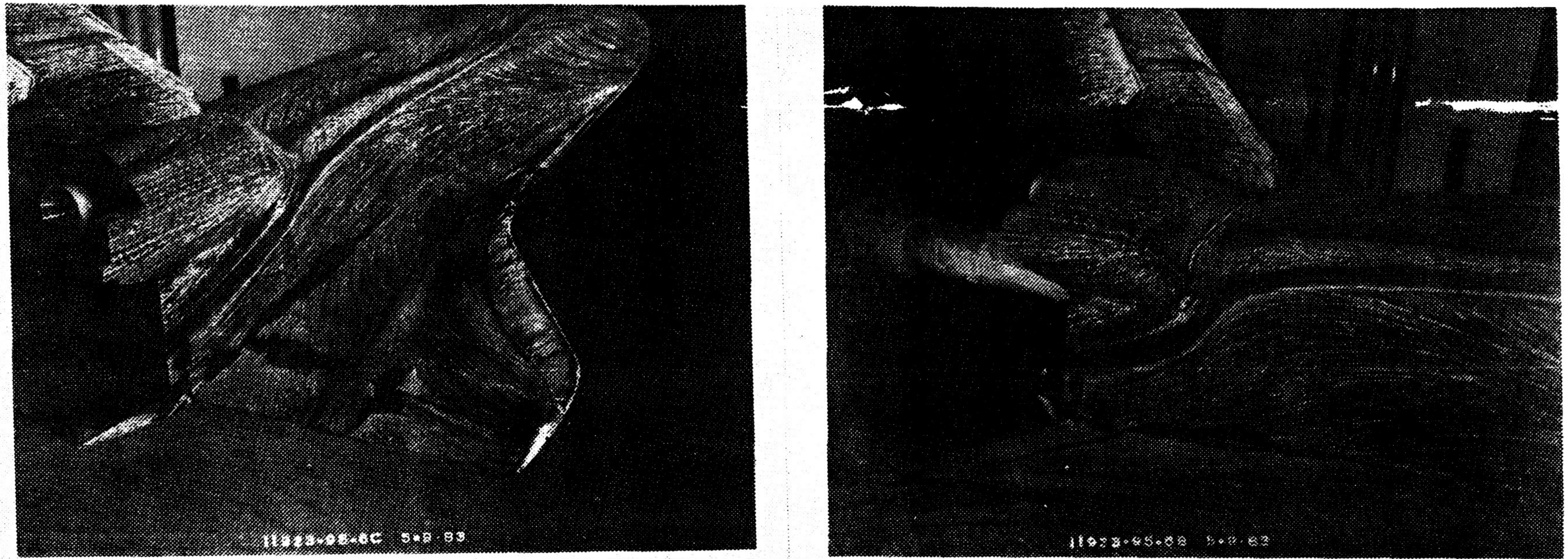
Angle of Attack = 25 Degrees



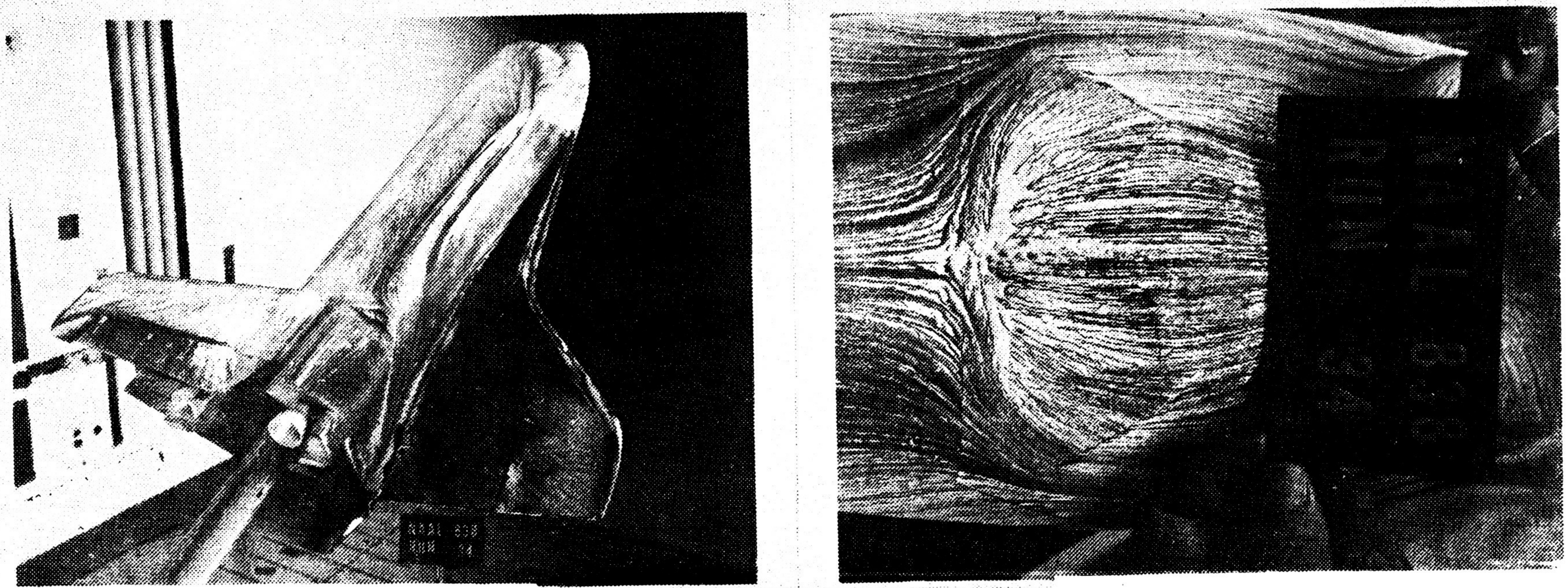
Angle of Attack = 30 Degrees



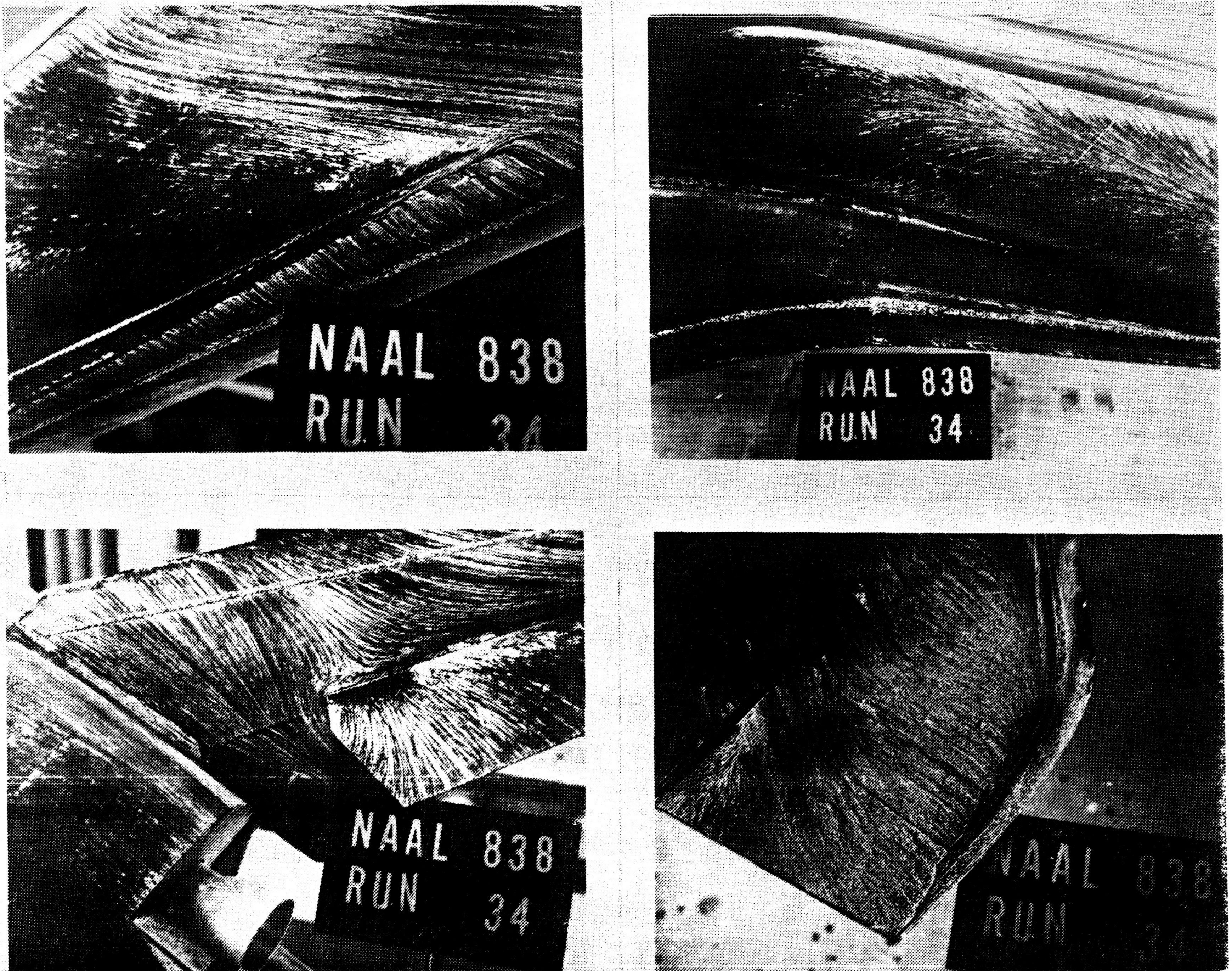
Run 33: Angle of Attack = 15 Degrees



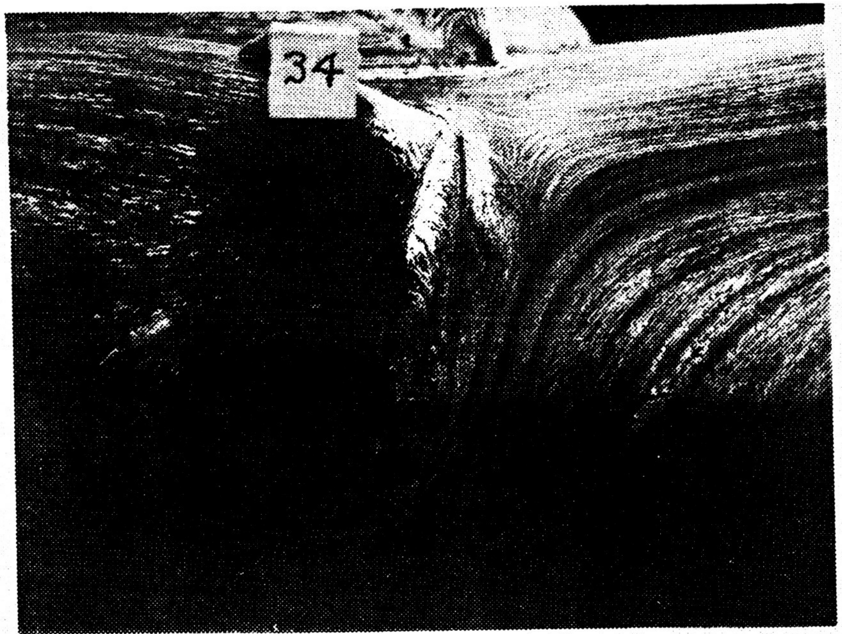
Run 33: Angle of Attack = 15 Degrees

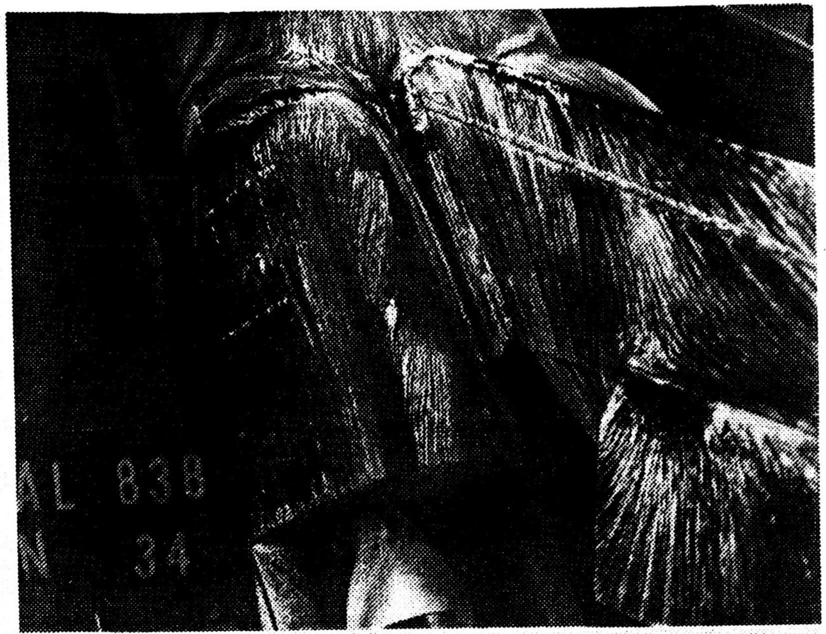


Run 34: Angle of Attack = 30 Degrees

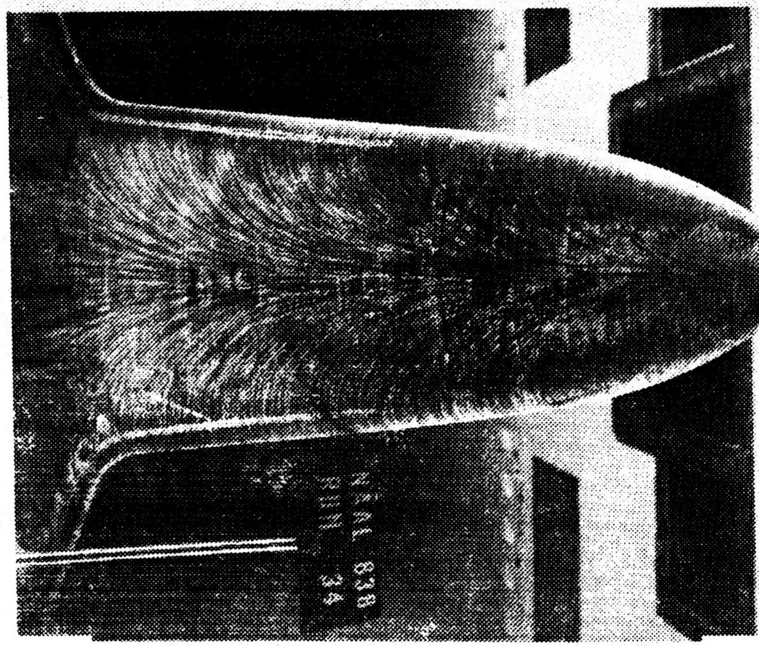


Run 34: Angle of Attack = 30 Degrees

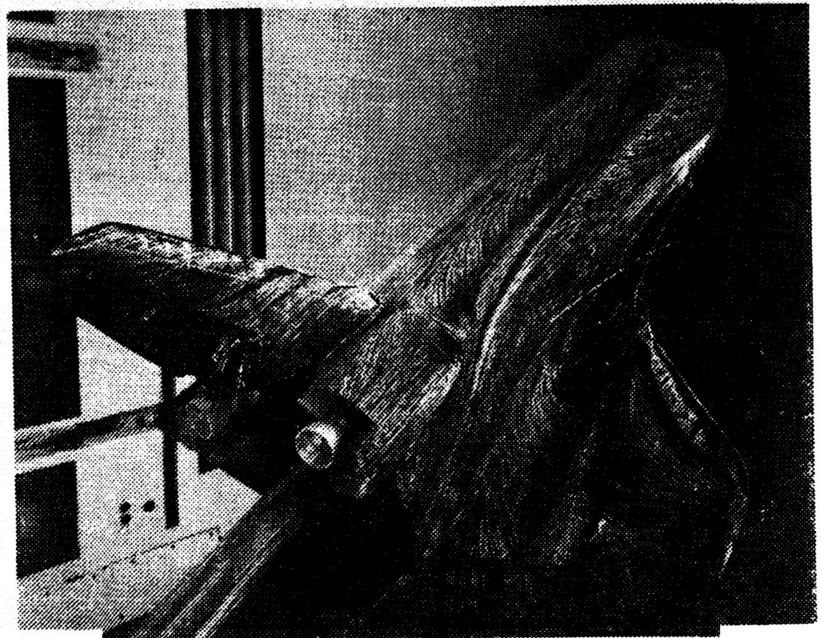




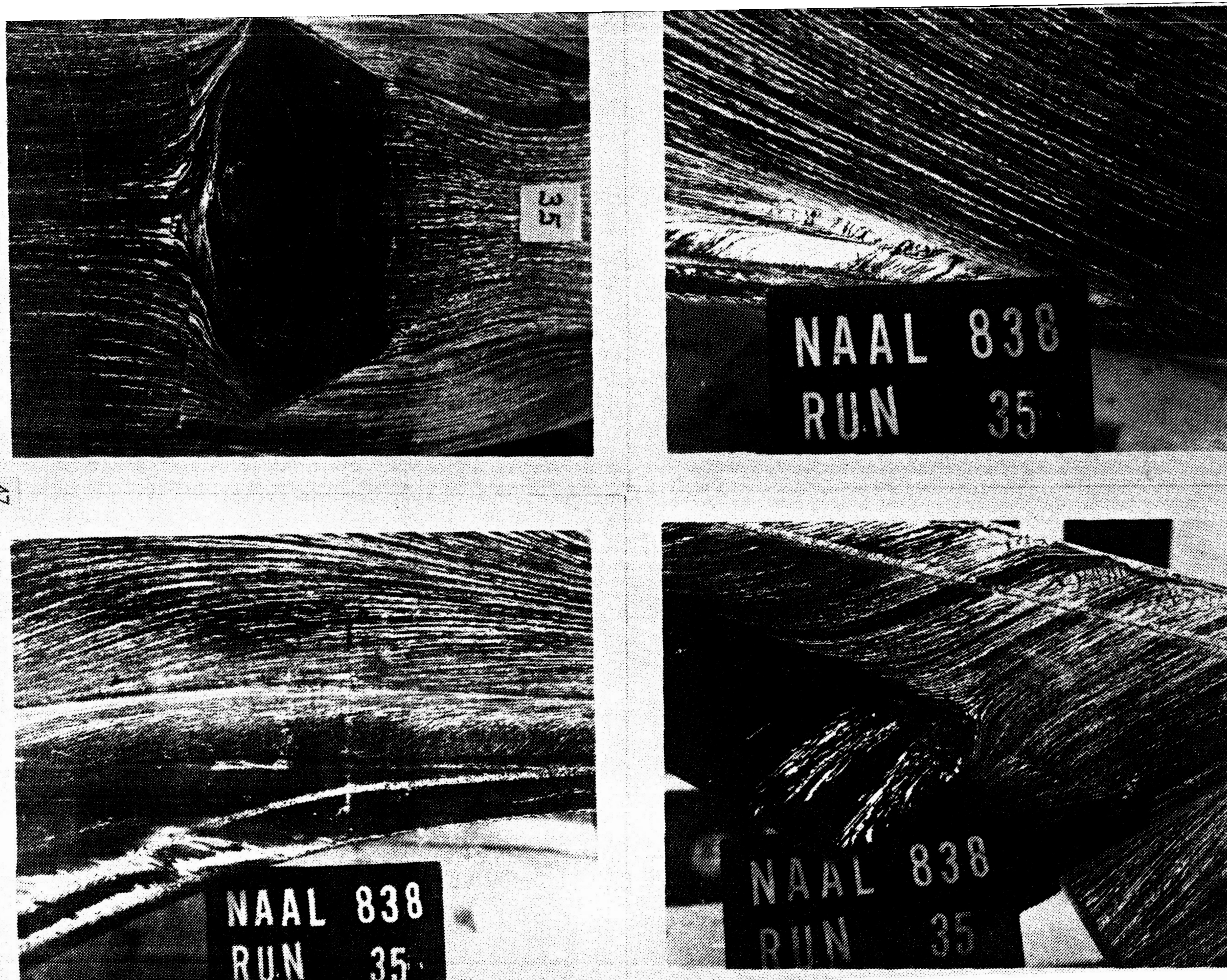
Run 34: Angle of Attack = 30 Degrees



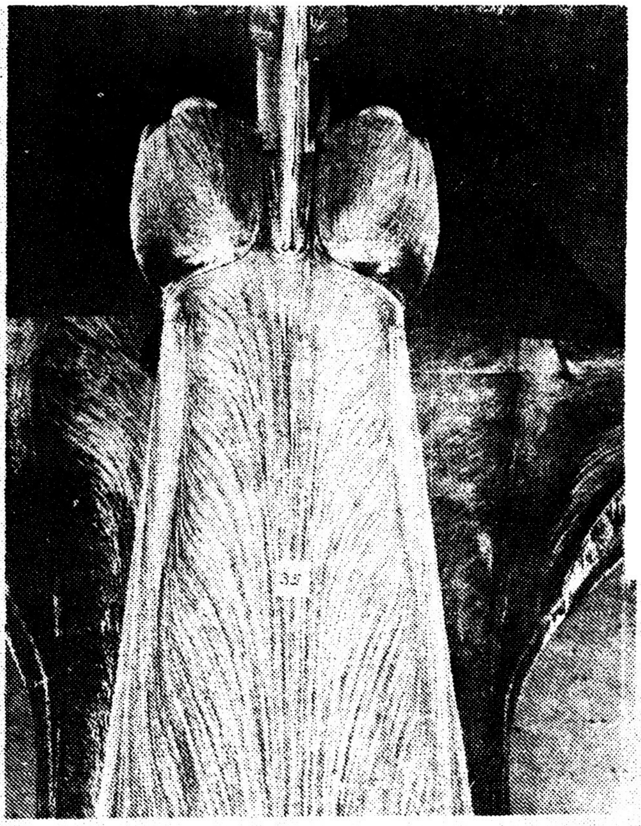
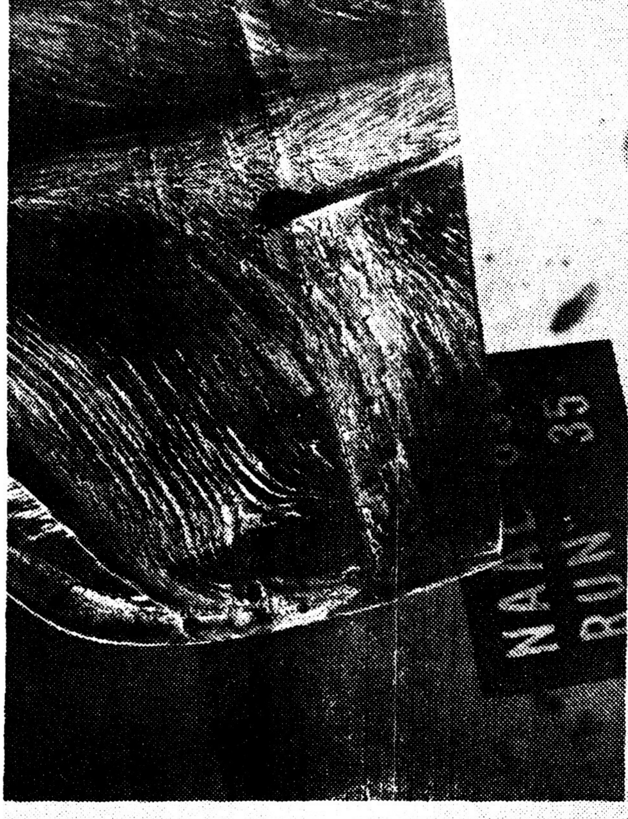
Run 34: Angle of Attack = 30 Degrees



Run 35: Angle of Attack = 15 Degrees



Run 35: Angle of Attack = 15 Degrees


35

35

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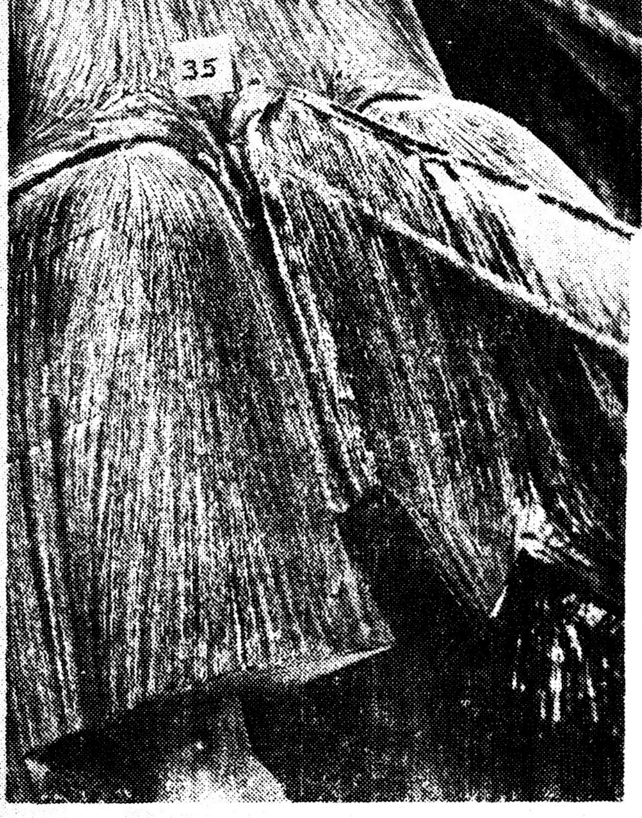
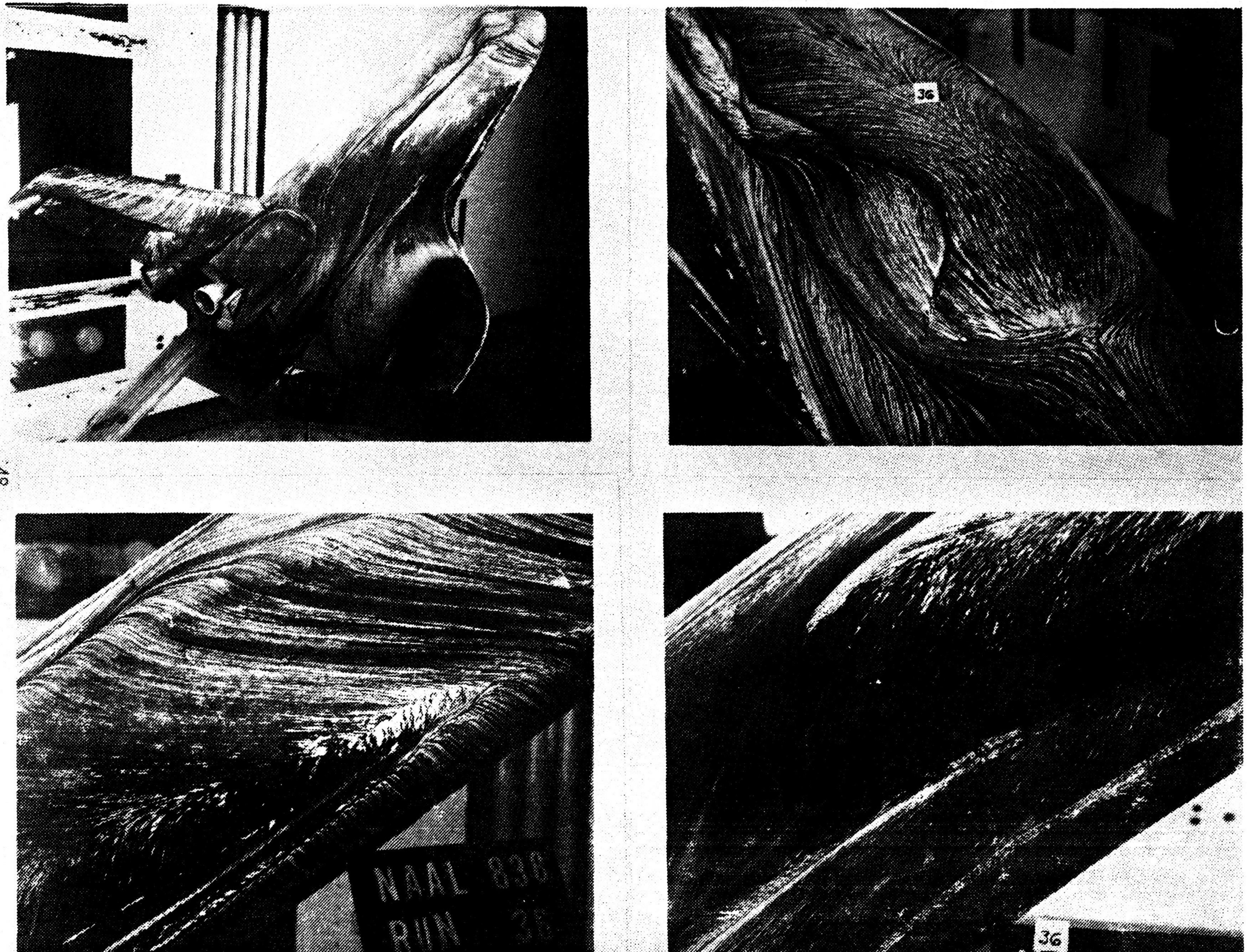
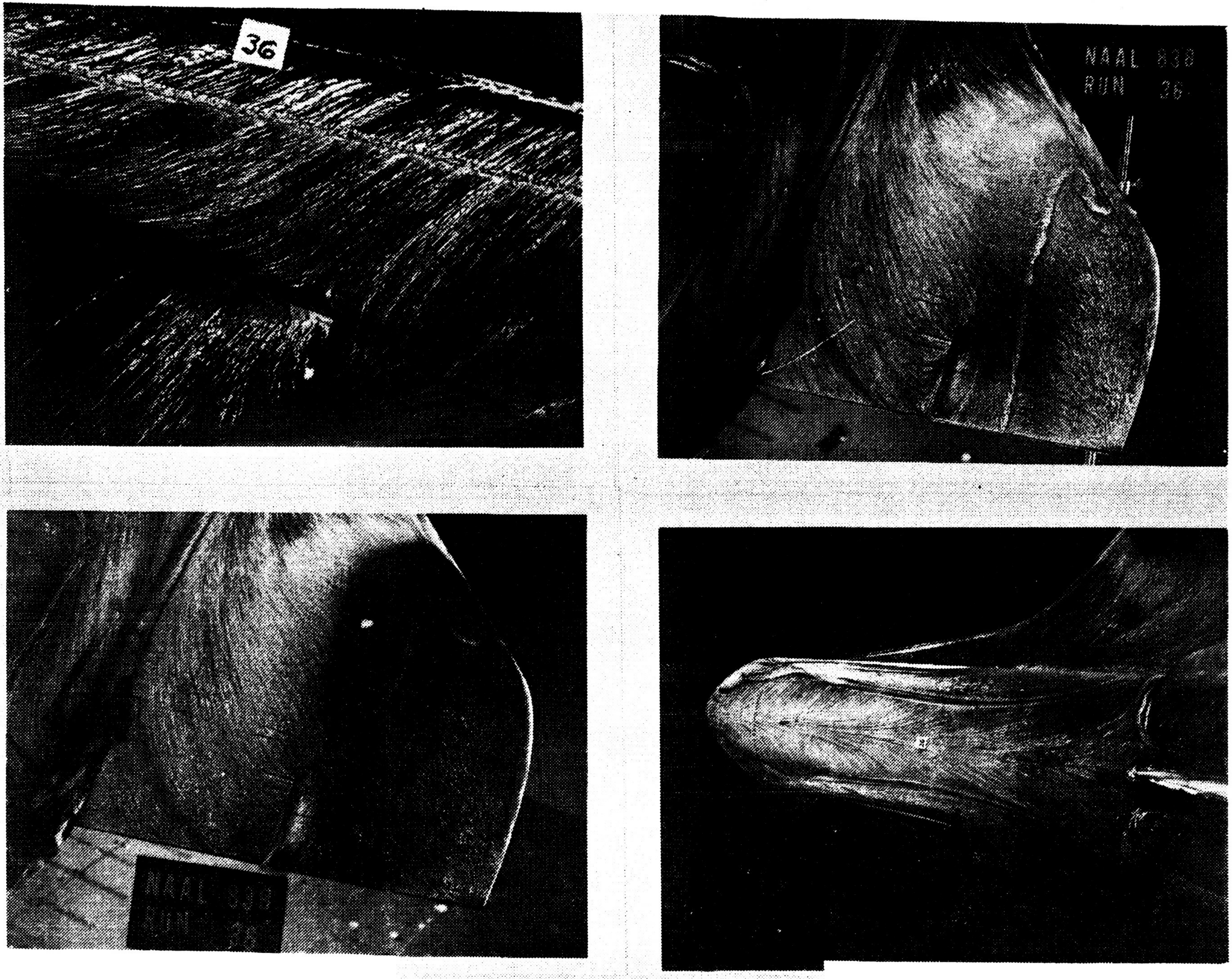
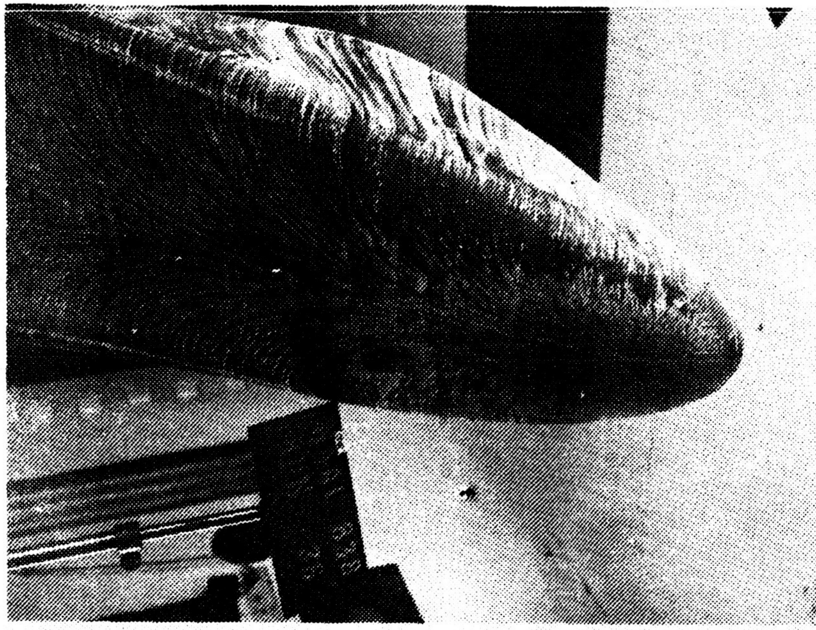

35

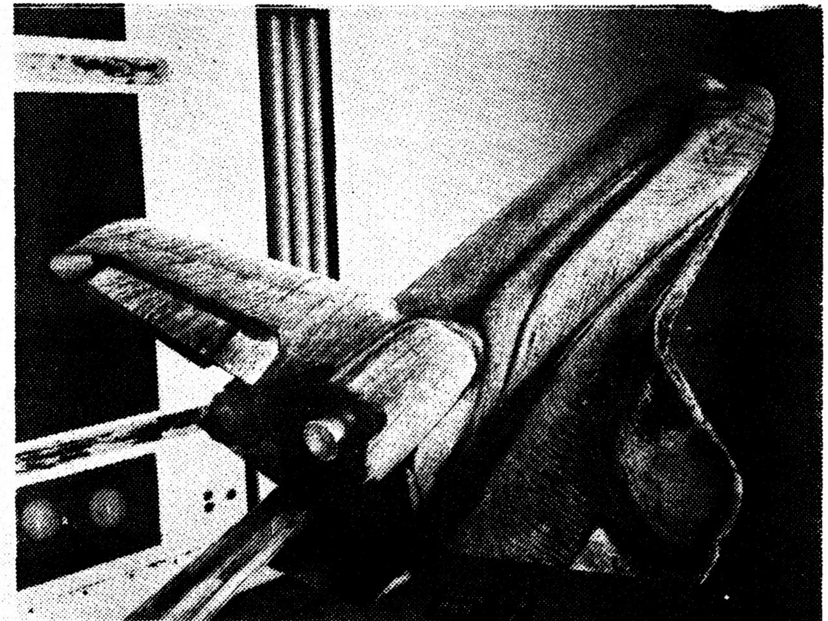


Run 36: Angle of Attack = 35 Degrees



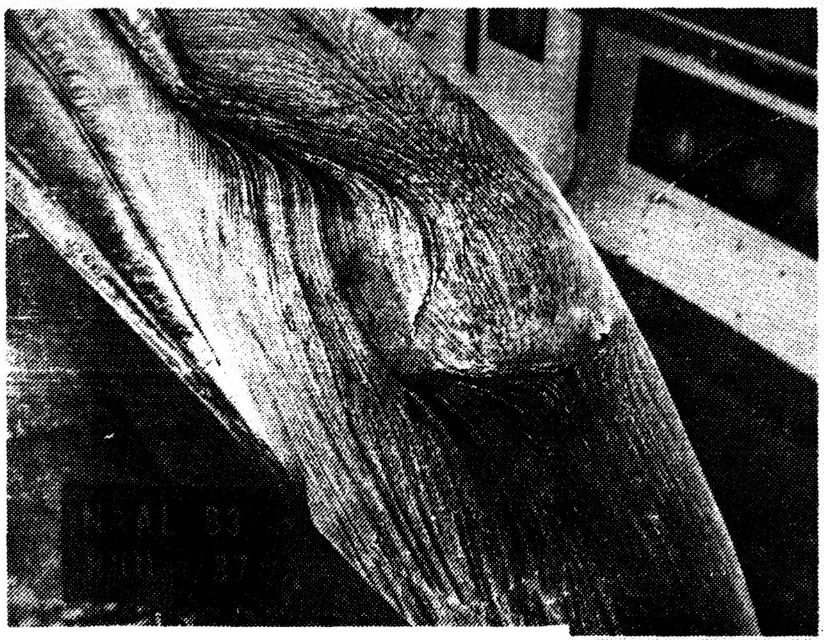
Run 36: Angle of Attack = 35 Degrees

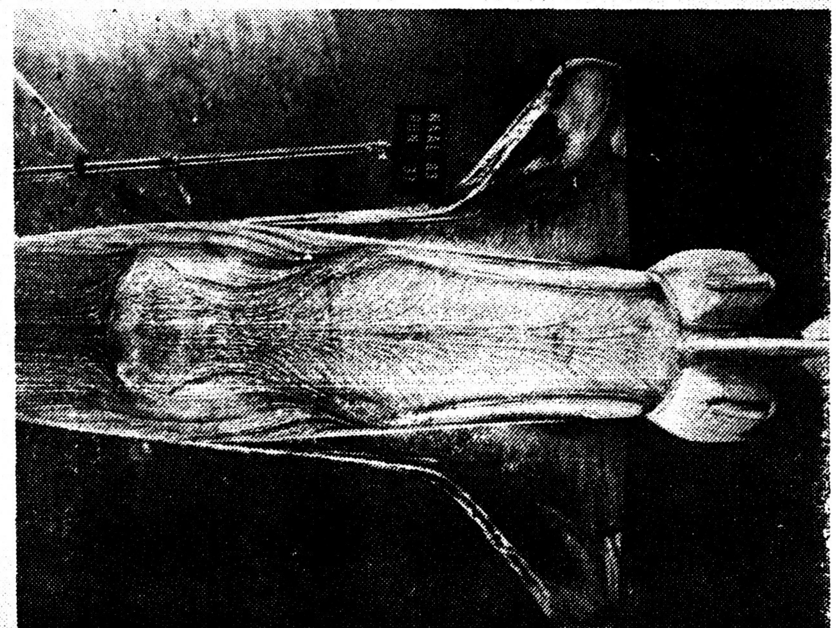




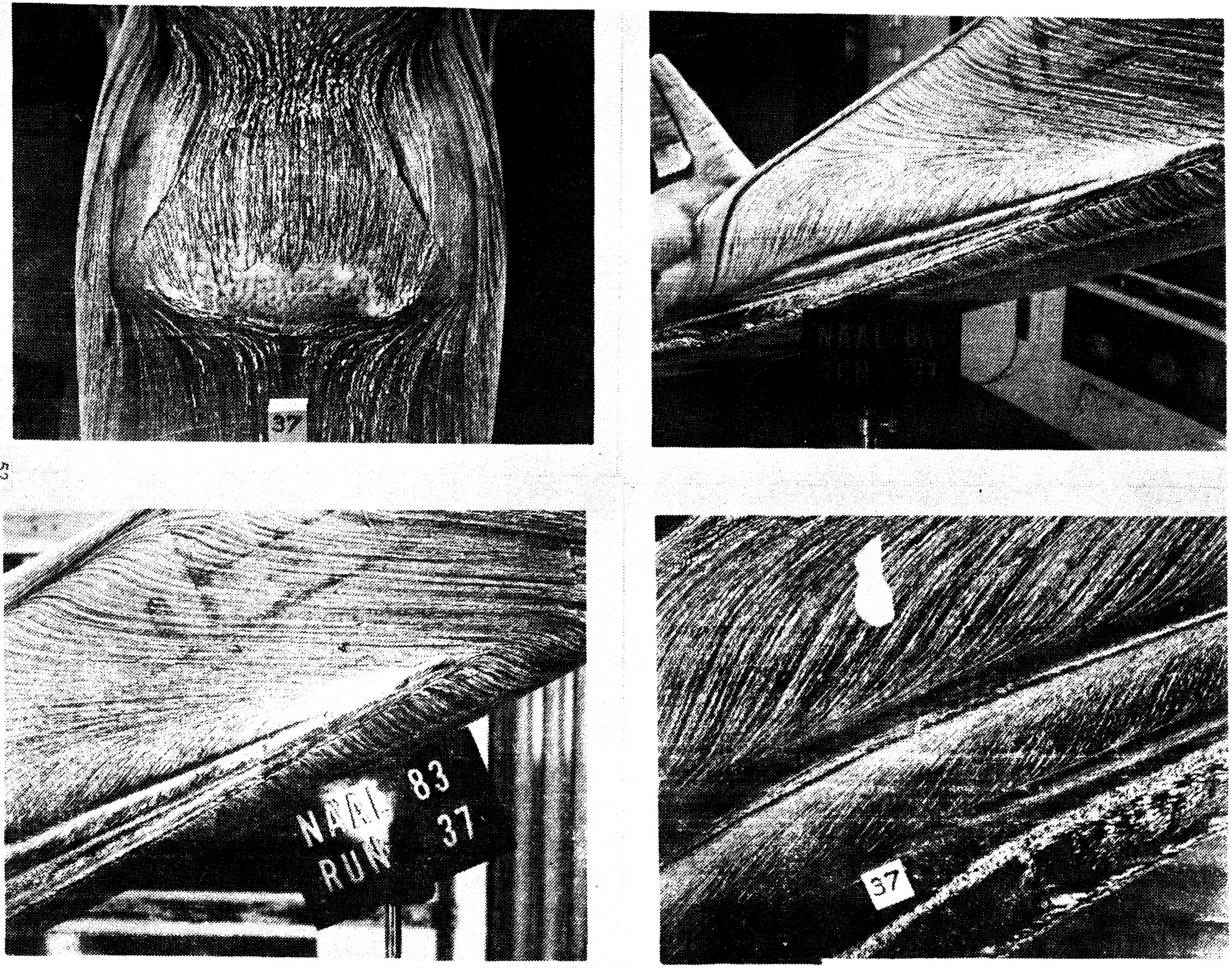
Run 36: Angle of Attack = 35 Degrees

Run 37: Angle of Attack = 25 Degrees

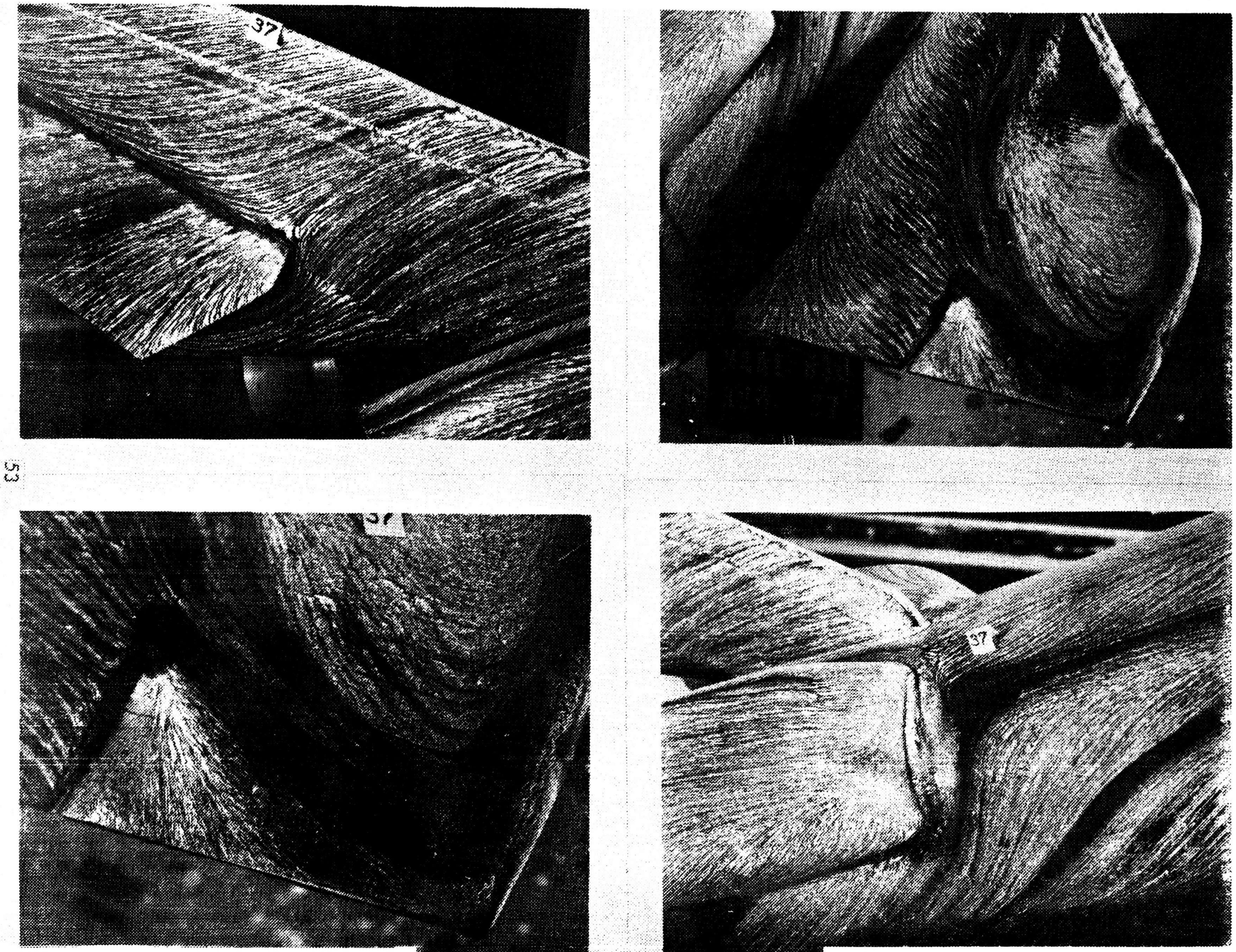




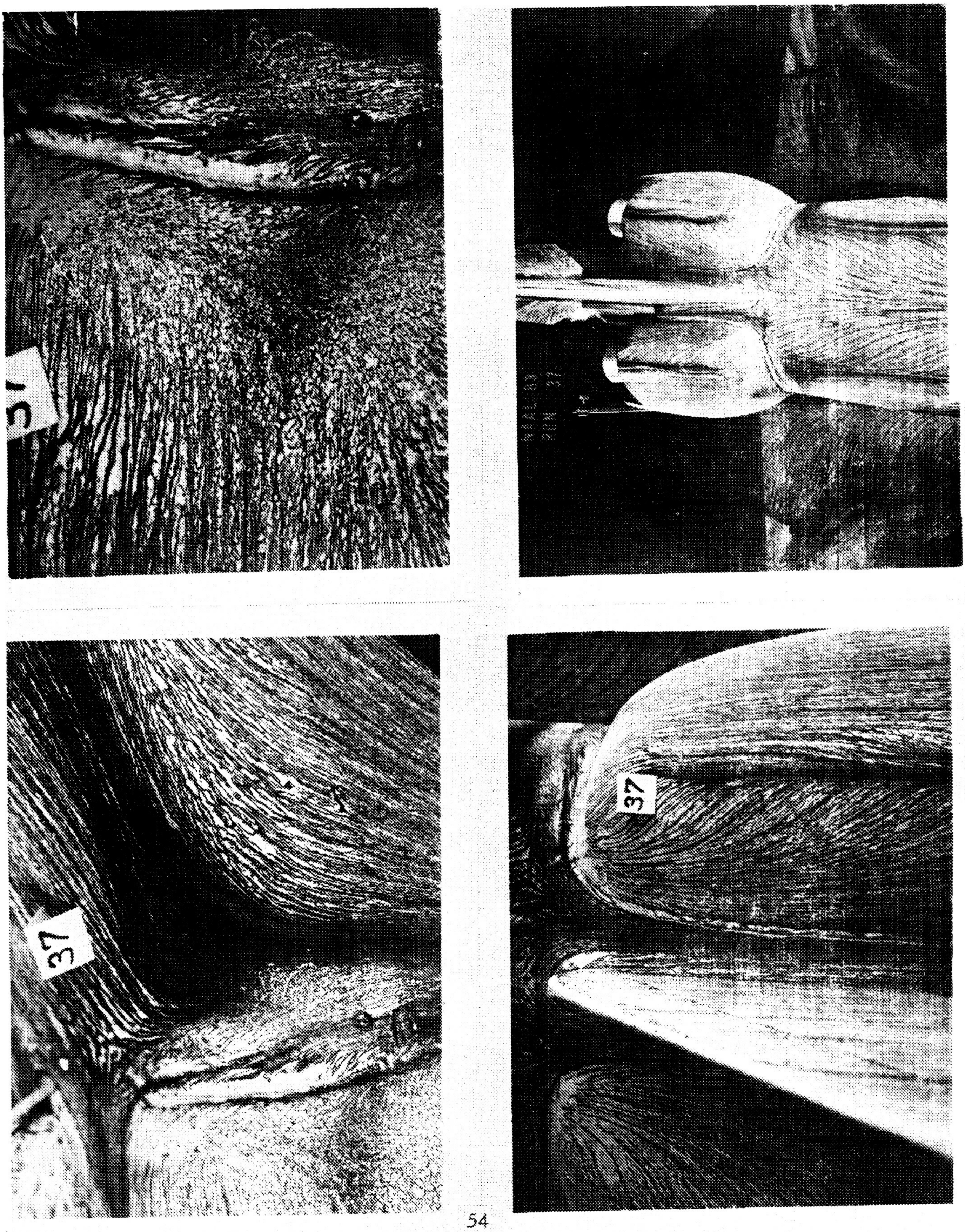
Run 37: Angle of Attack = 25 Degrees



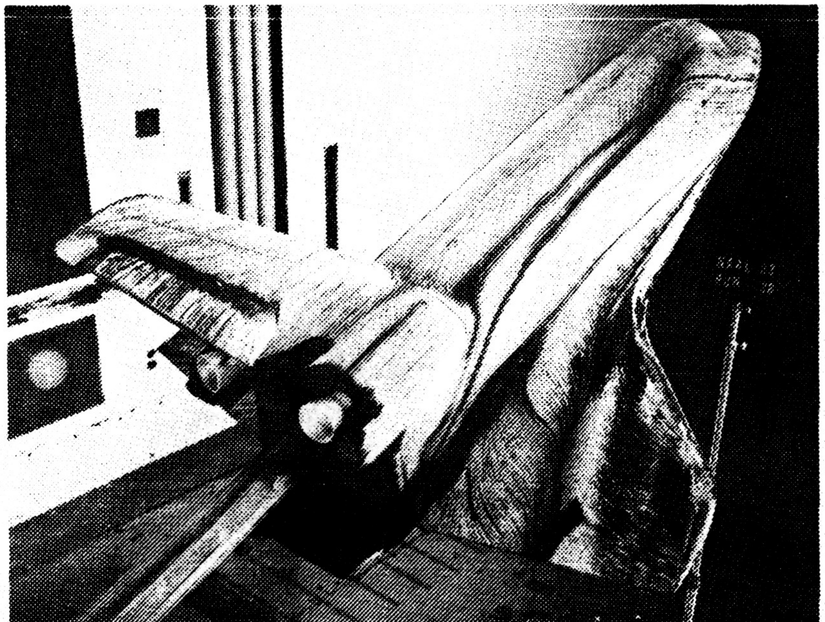
Run 37: Angle of Attack = 25 Degrees

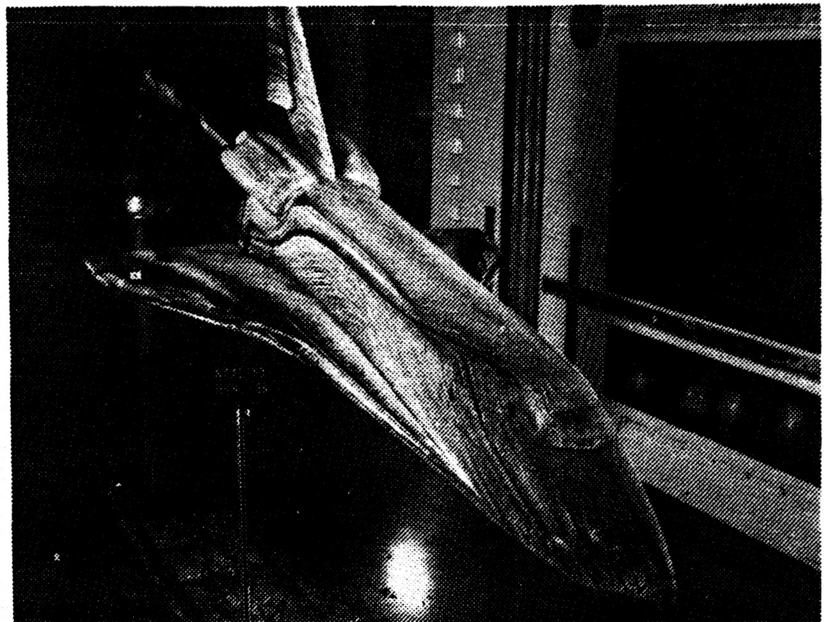


Run 37: Angle of Attack = 25 Degrees

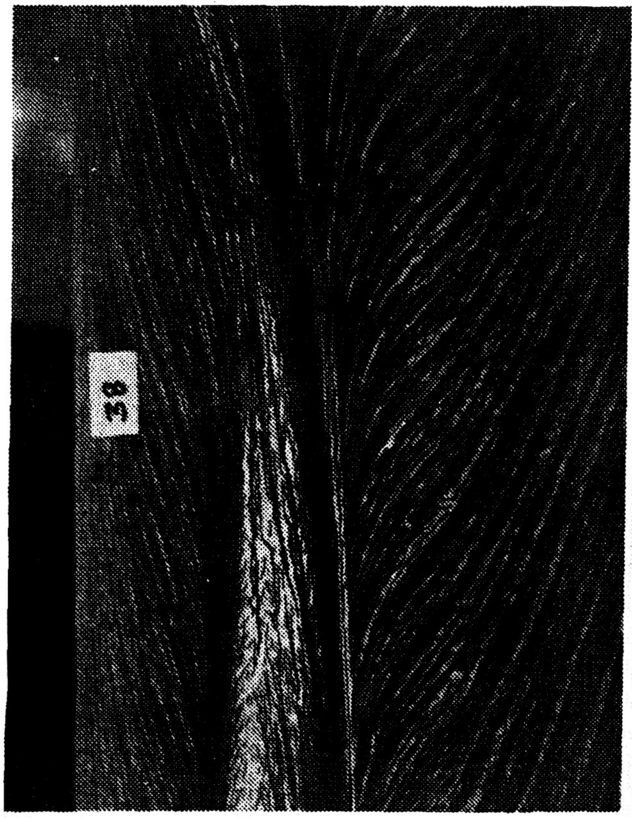


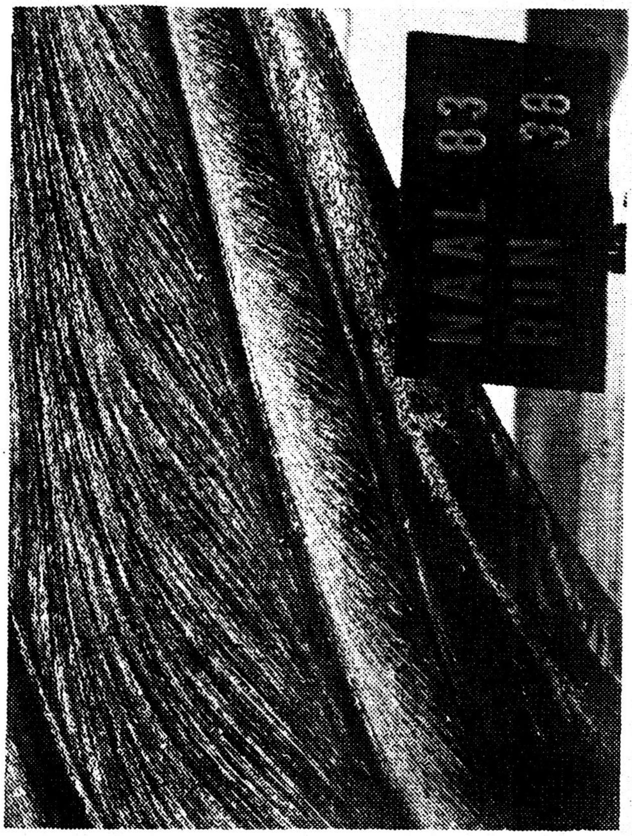
37, Angle of Attack = 35 Degrees

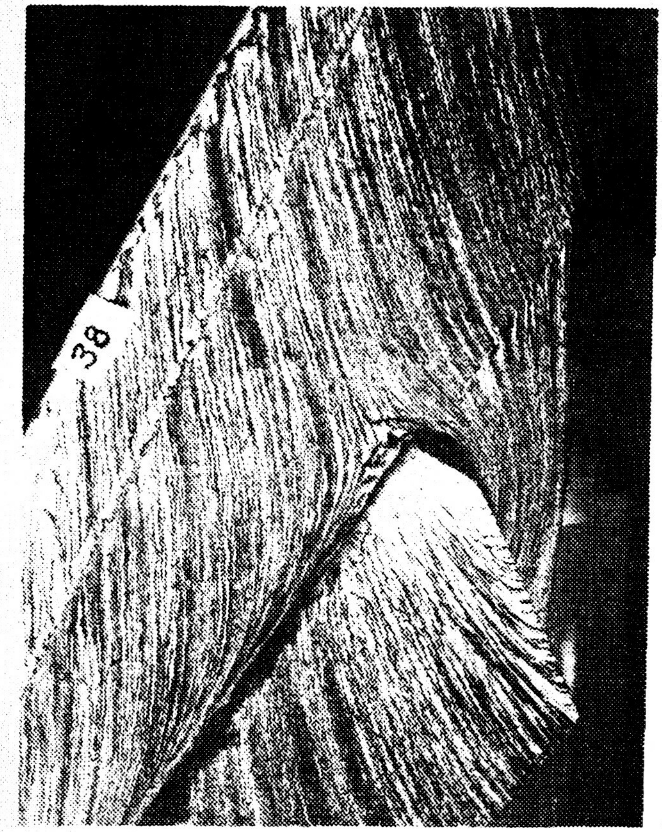


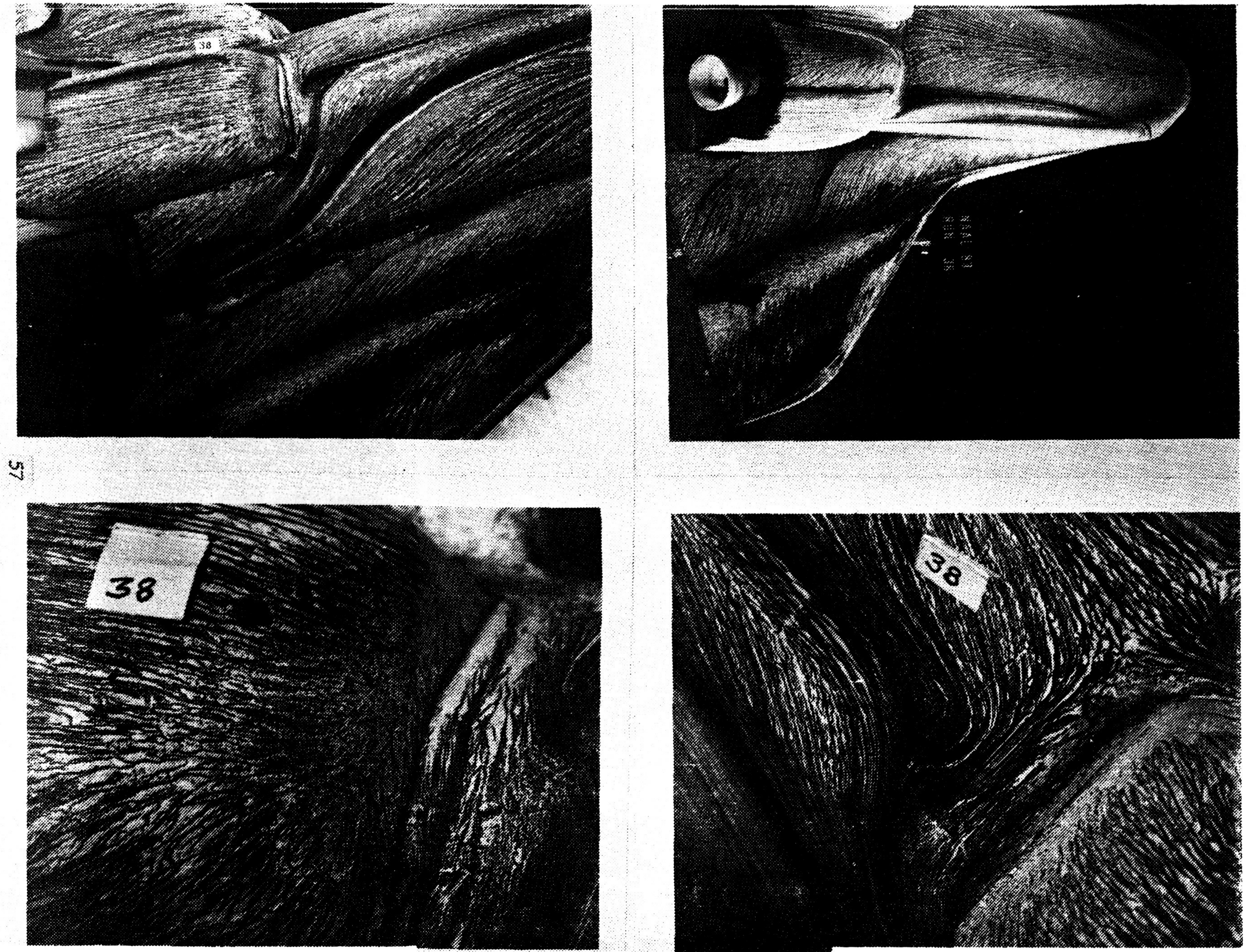


Run 38: Angle of Attack = 20 Degrees

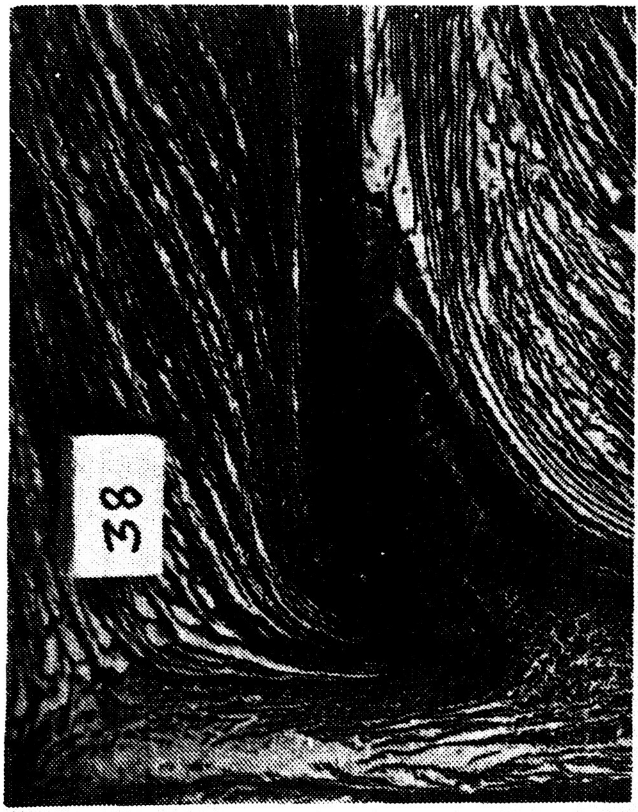
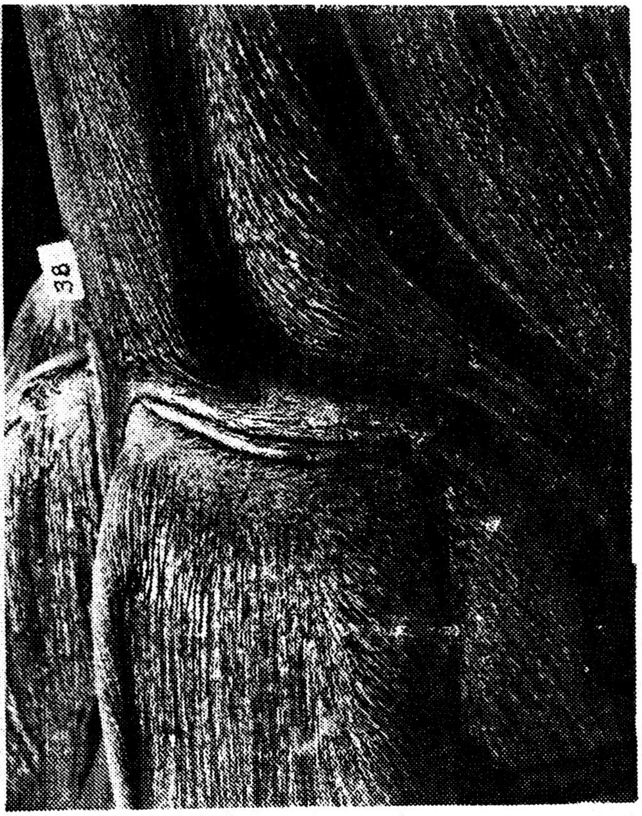
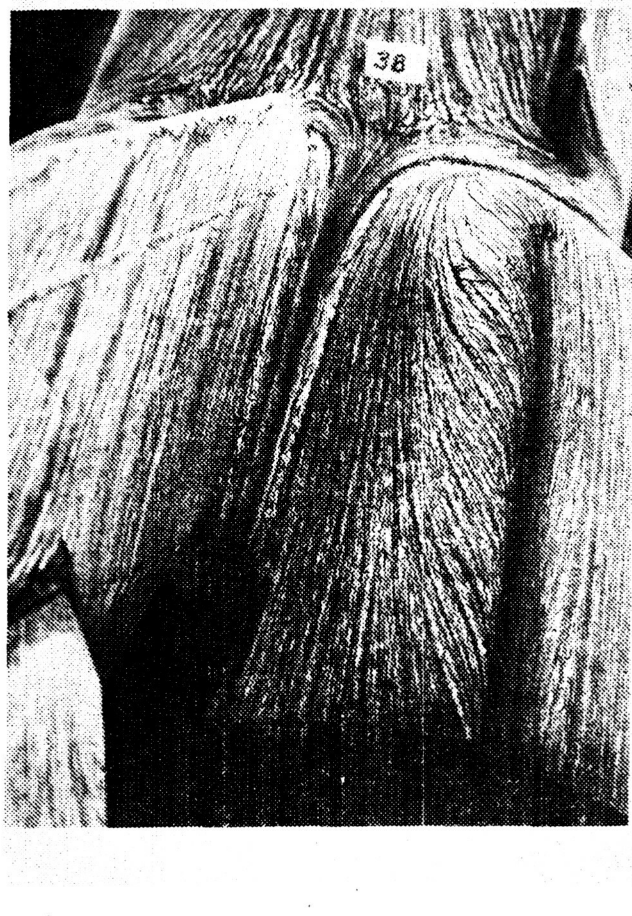

38


NAVAL 83
RUN 38


38



Run 38: Angle of Attack = 20 Degrees


38

38

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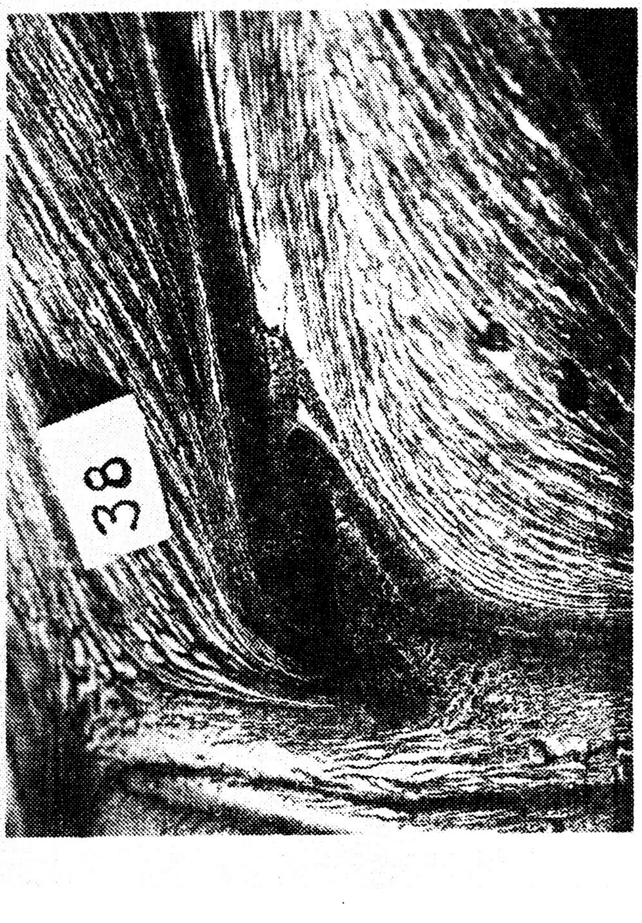
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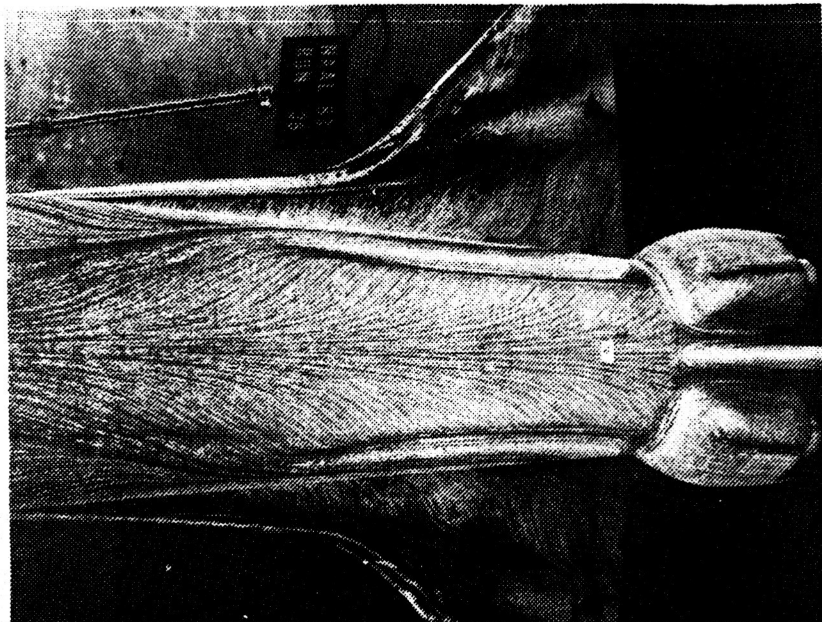
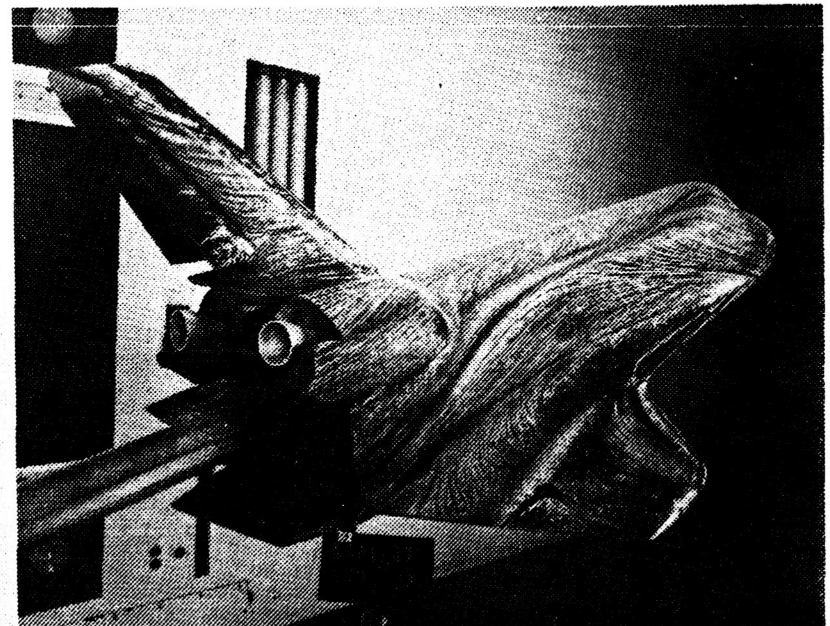
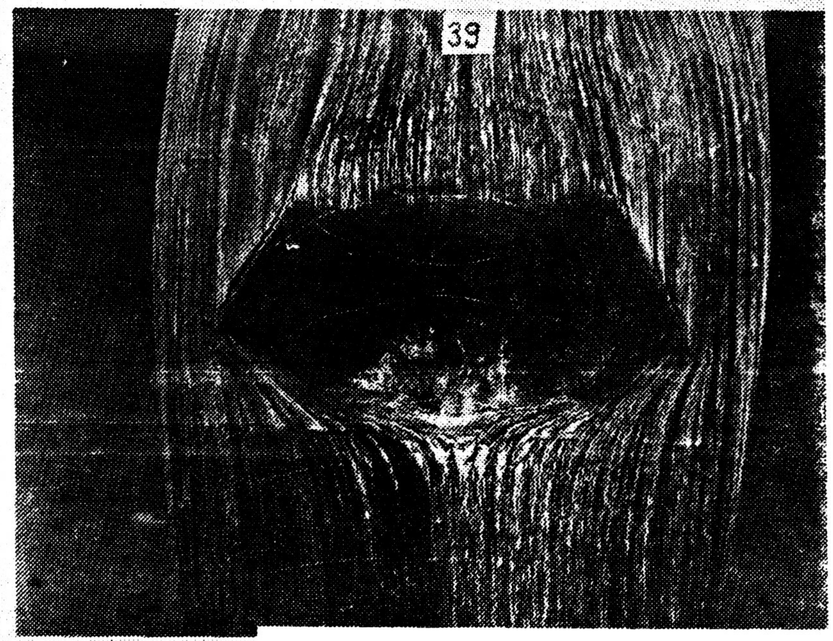


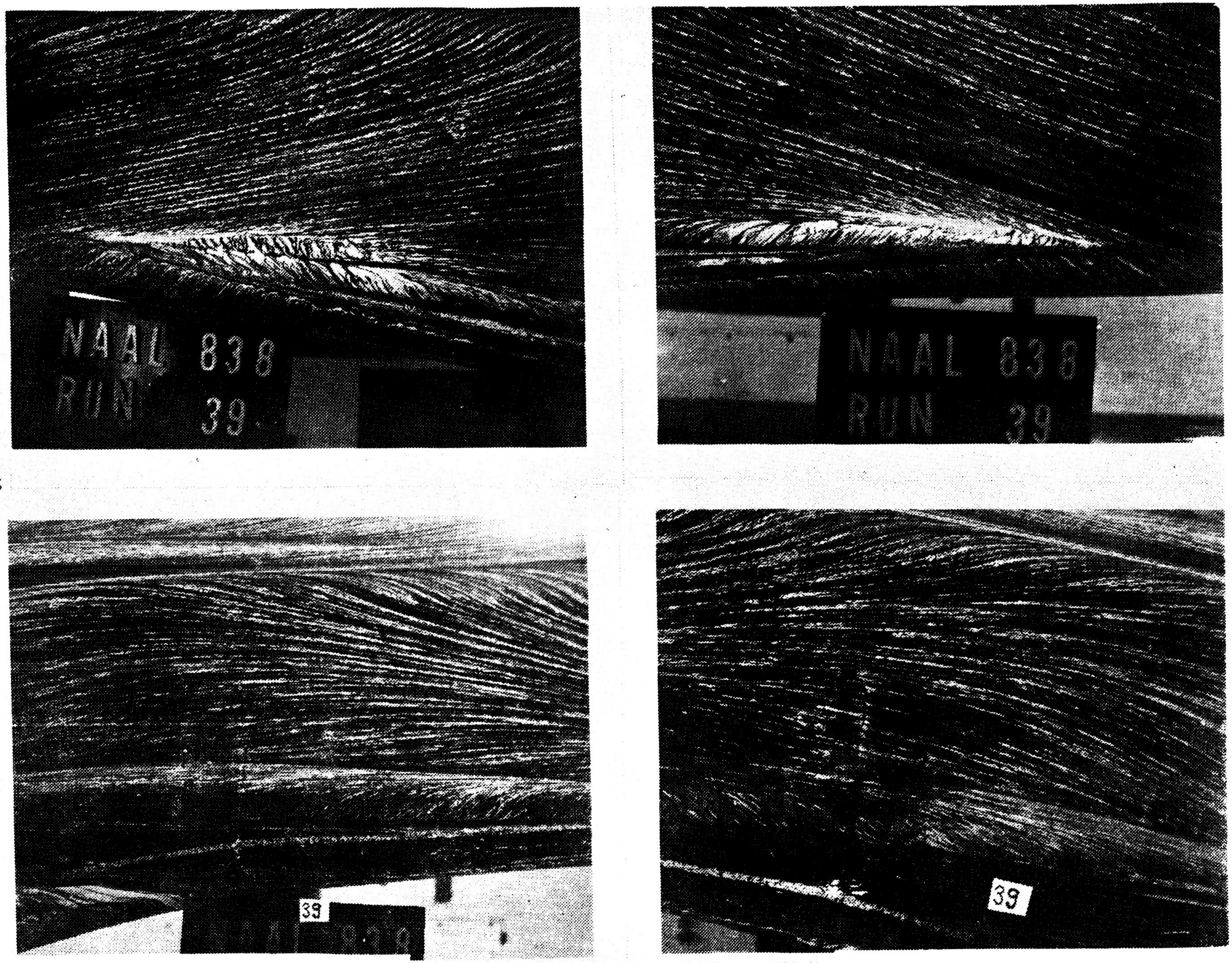
Run 38: Angle of Attack = 20 Degrees



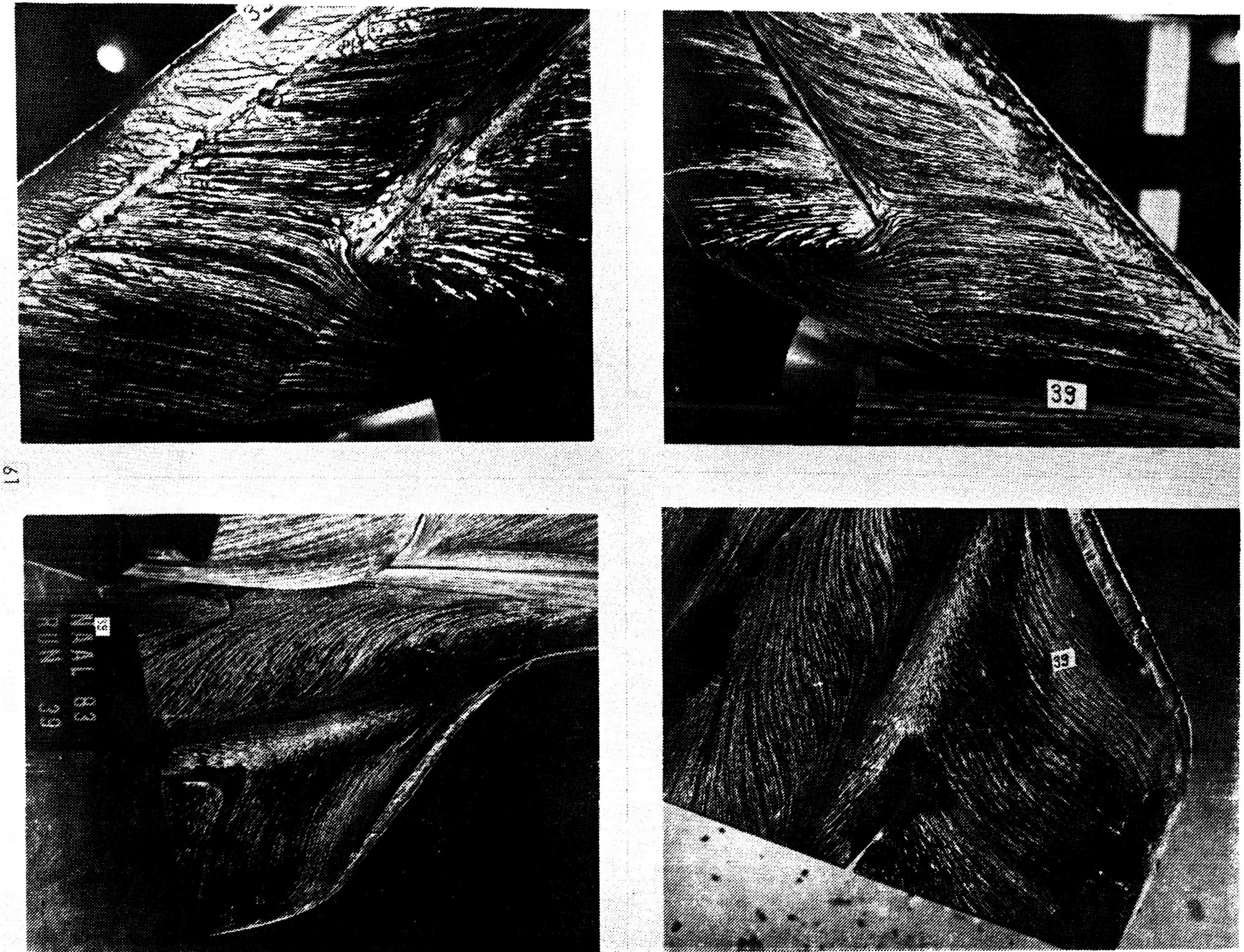
Run 39: Angle of Attack = 15 Degrees



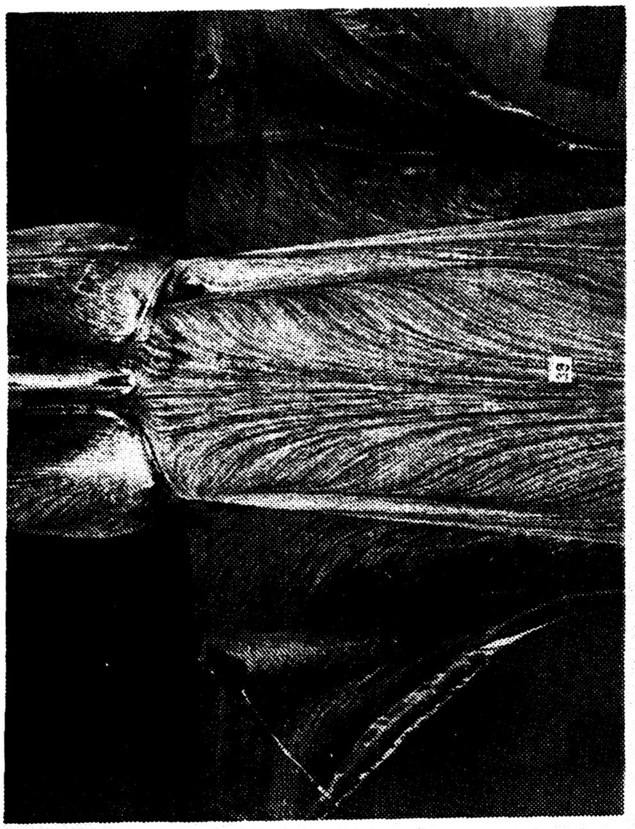
Run 39: Angle of Attack = 15 Degrees

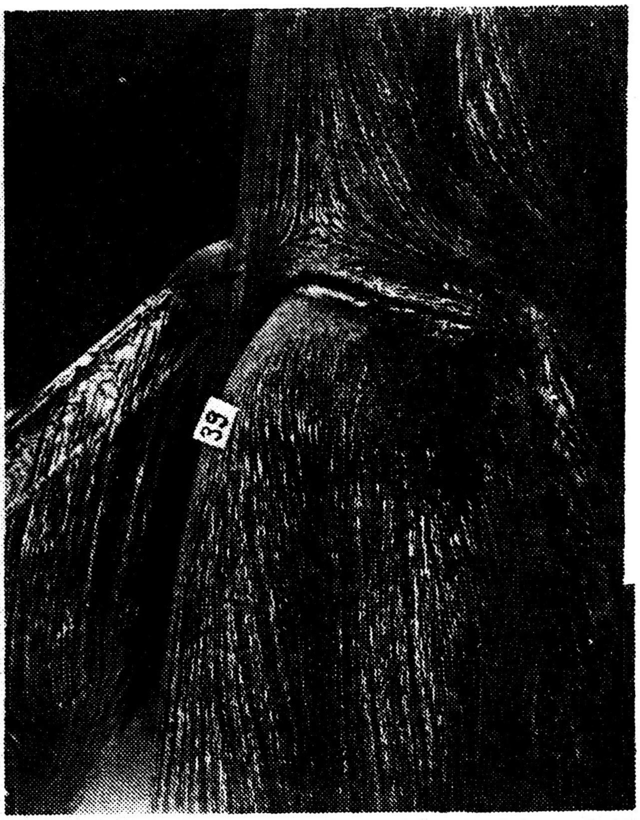


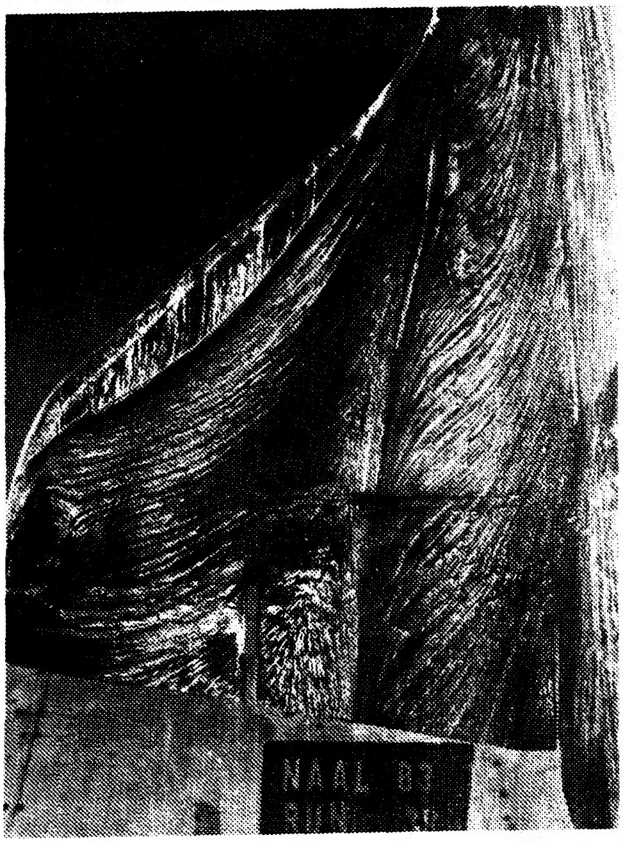
Attack = 15 Degrees

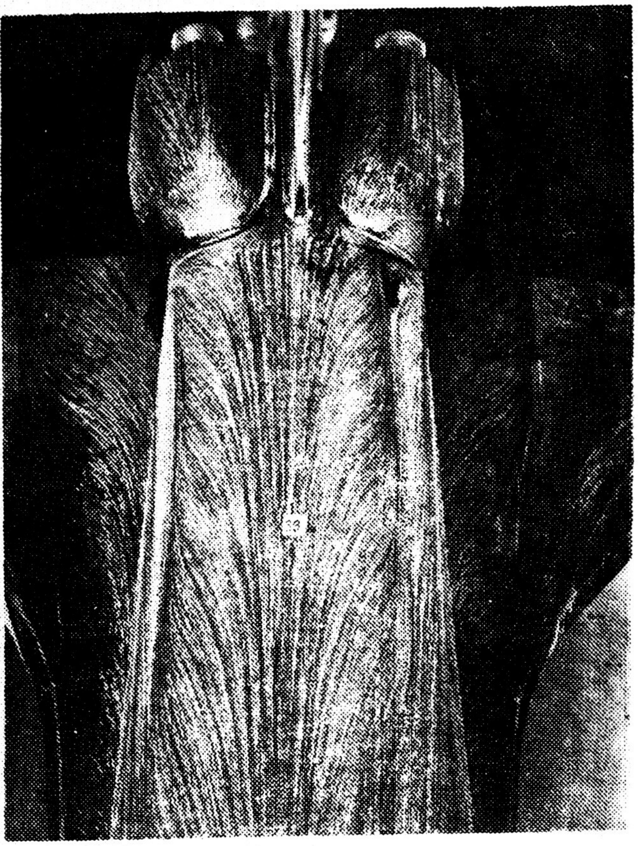


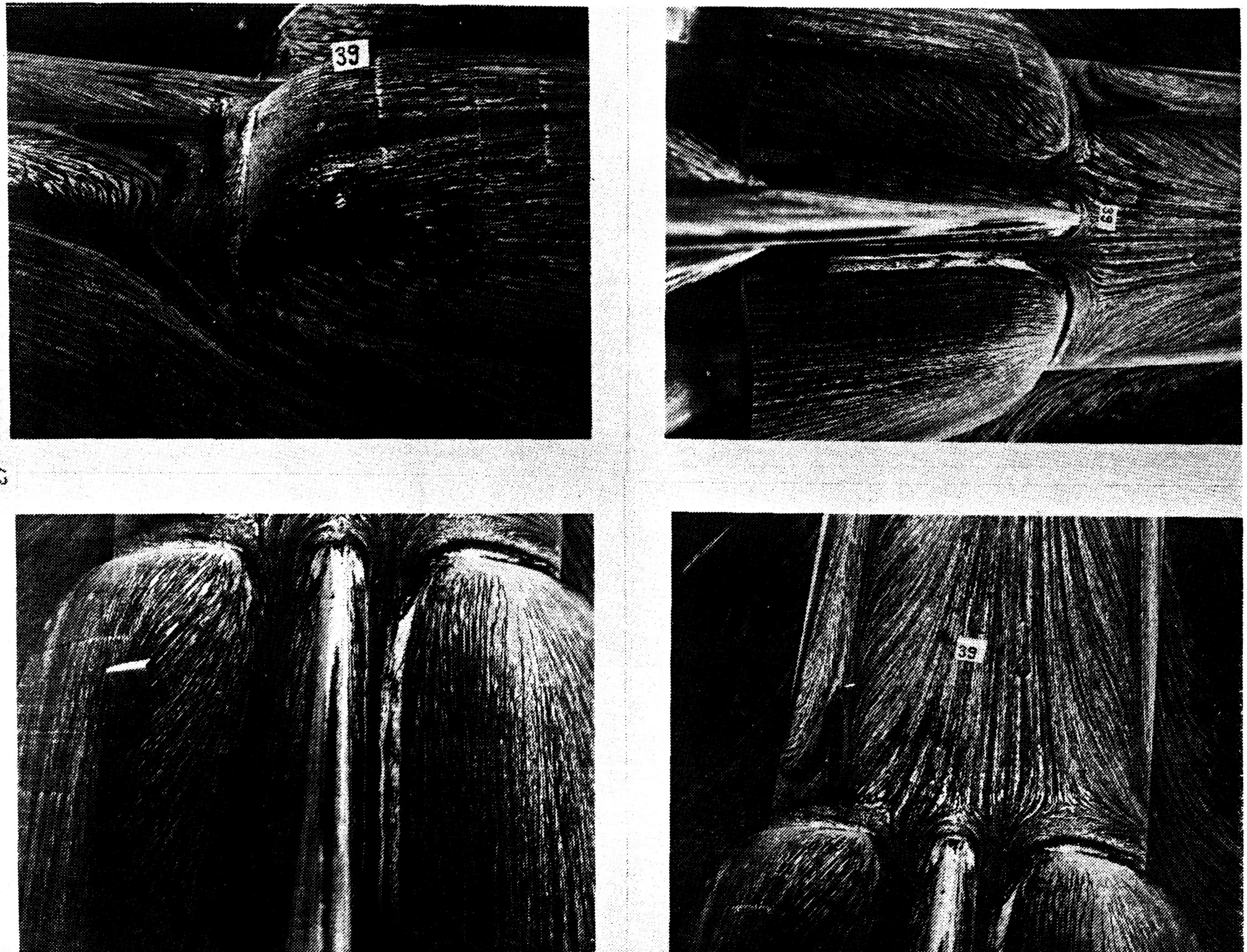
Run 39: Angle of Attack = 15 Degrees



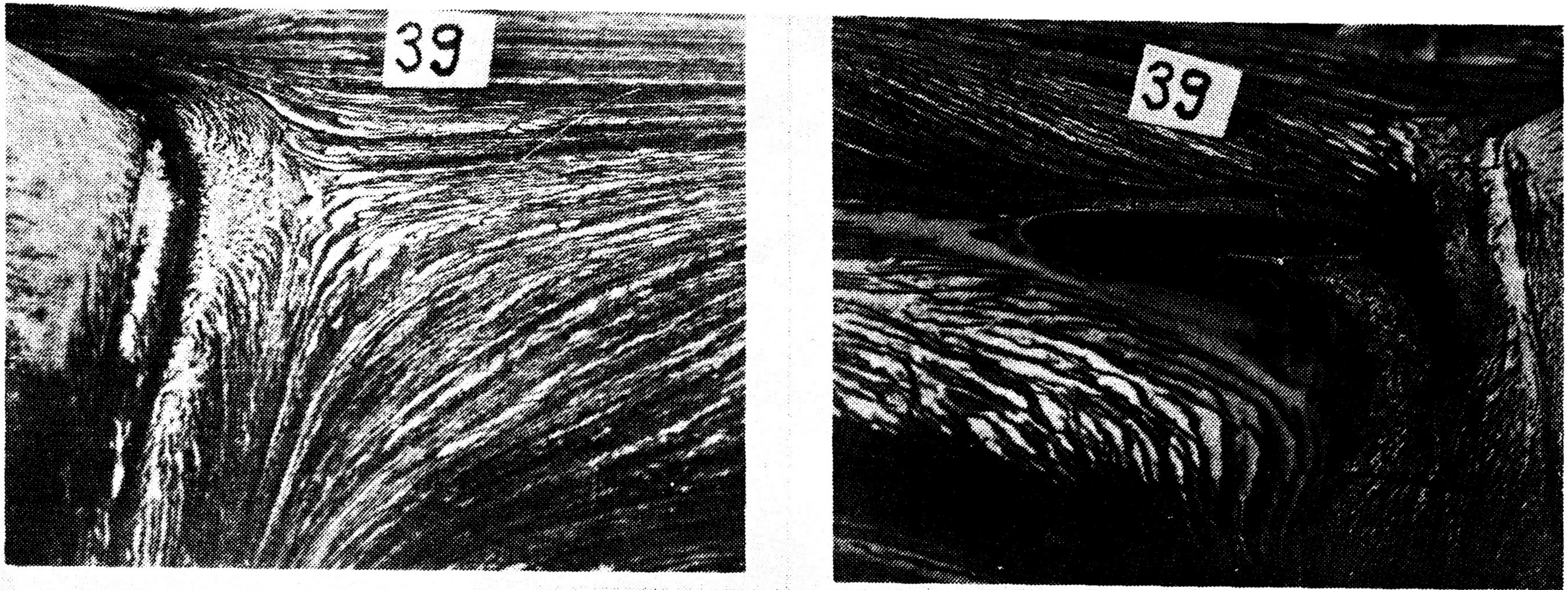

39



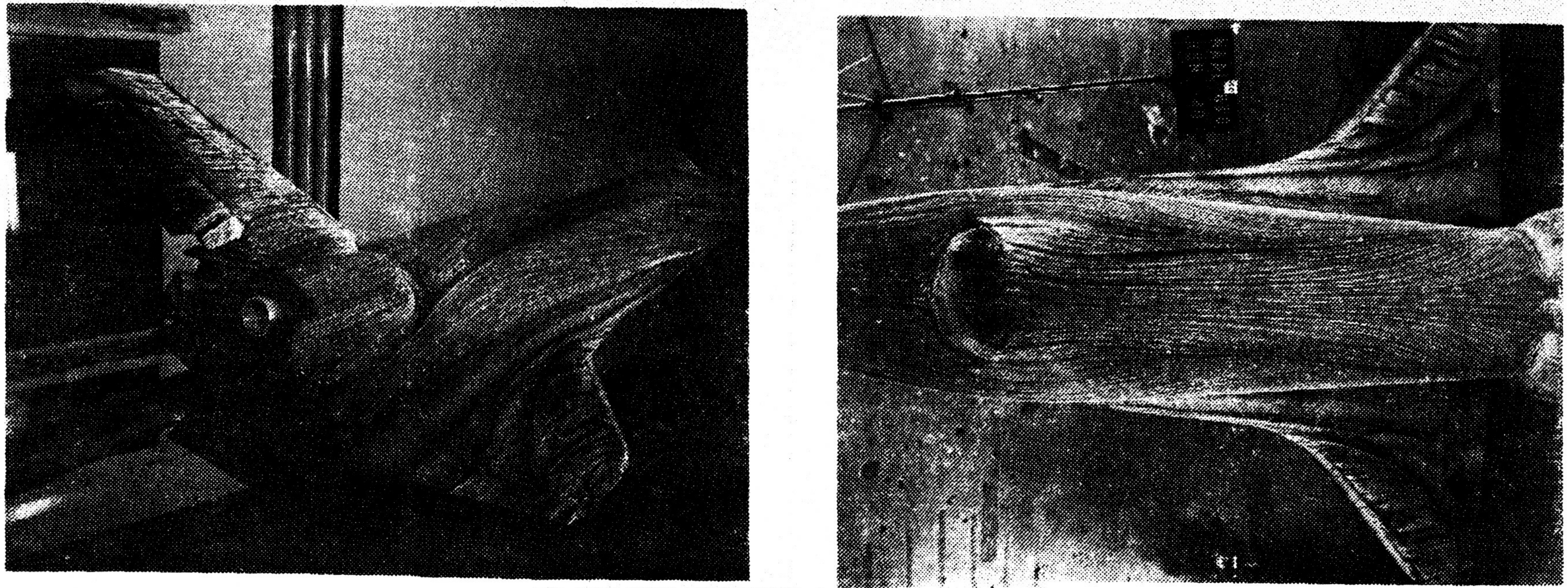




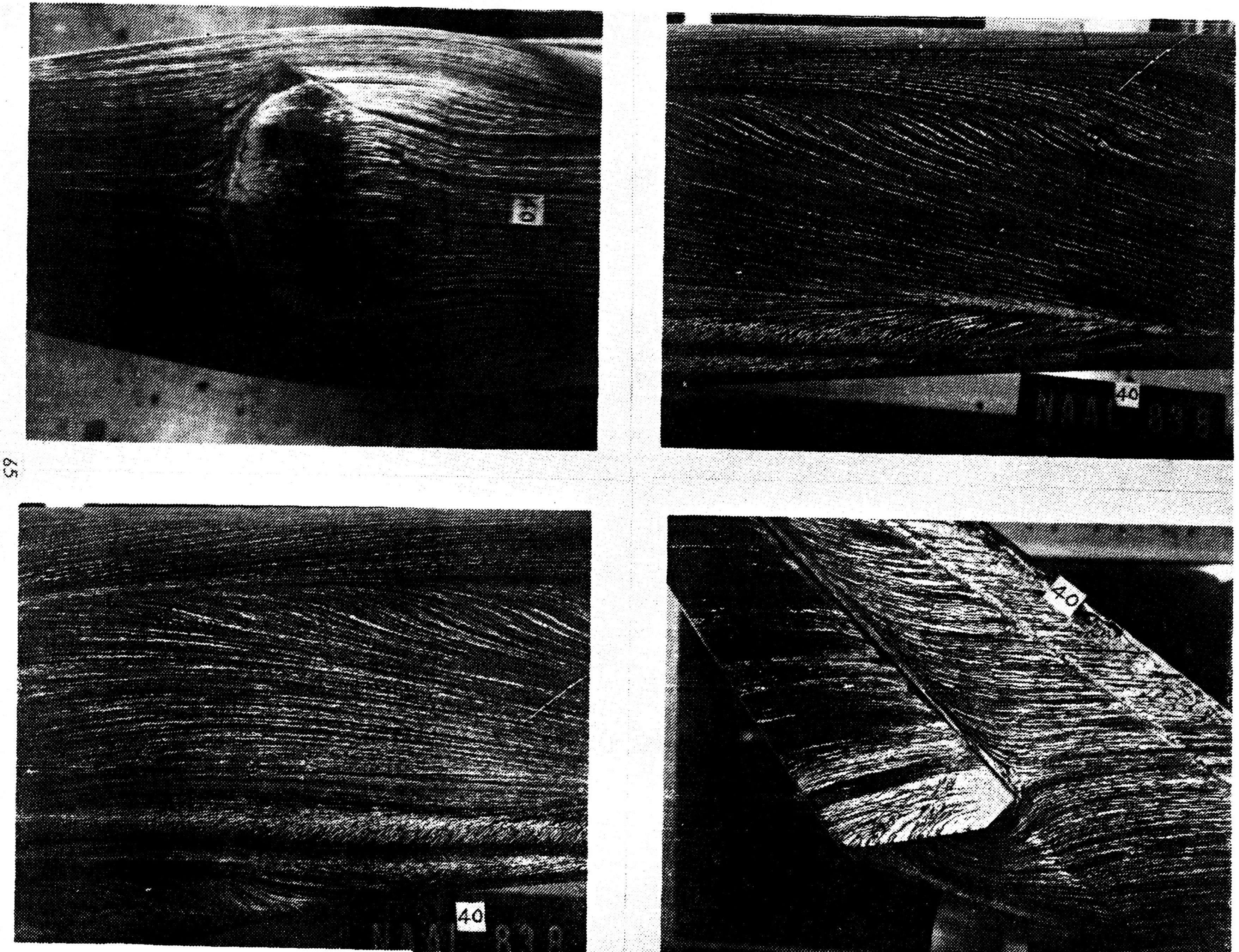
Run 39: Angle of Attack = 15 Degrees



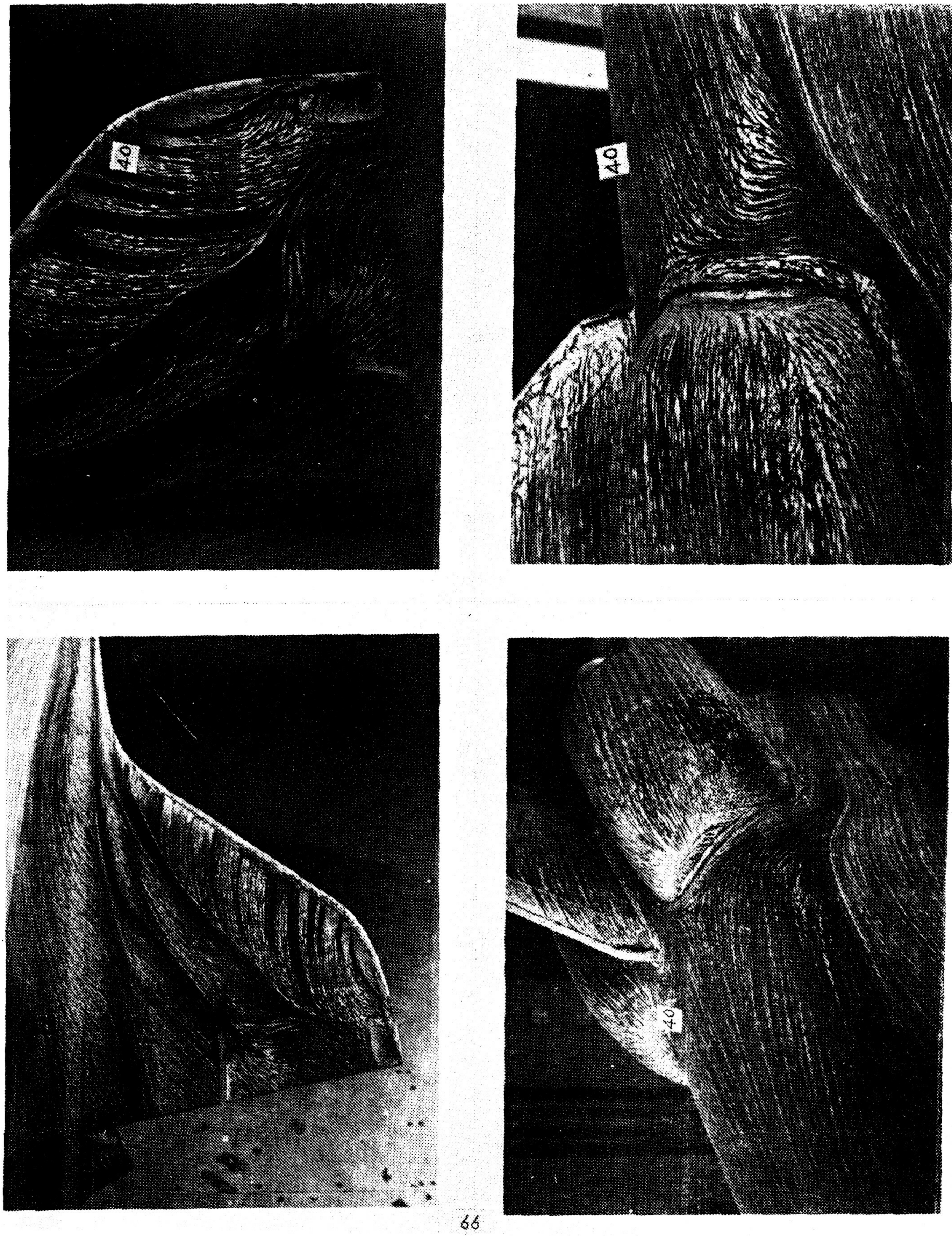
Run 39: Angle of Attack = 15 Degrees

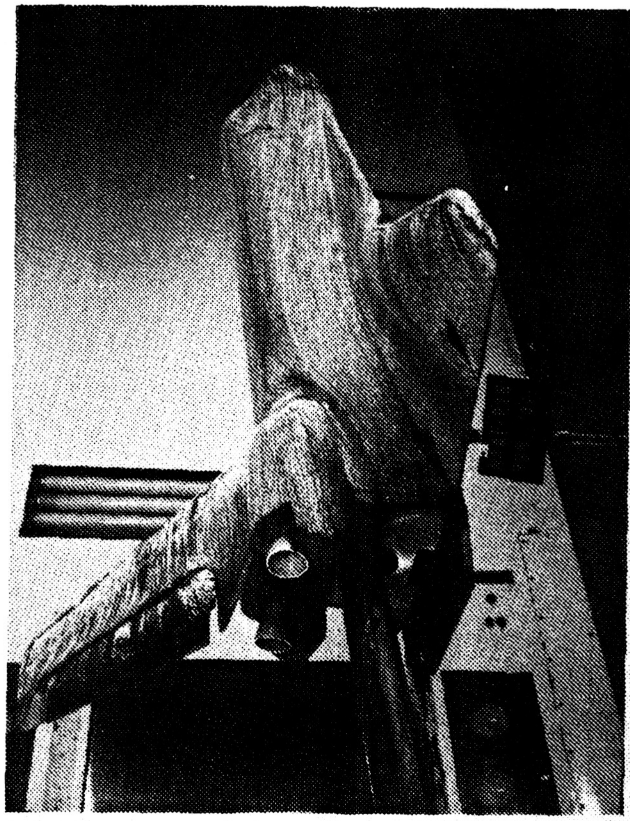


Run [illegible]: Angle of Attack = 10 Degrees

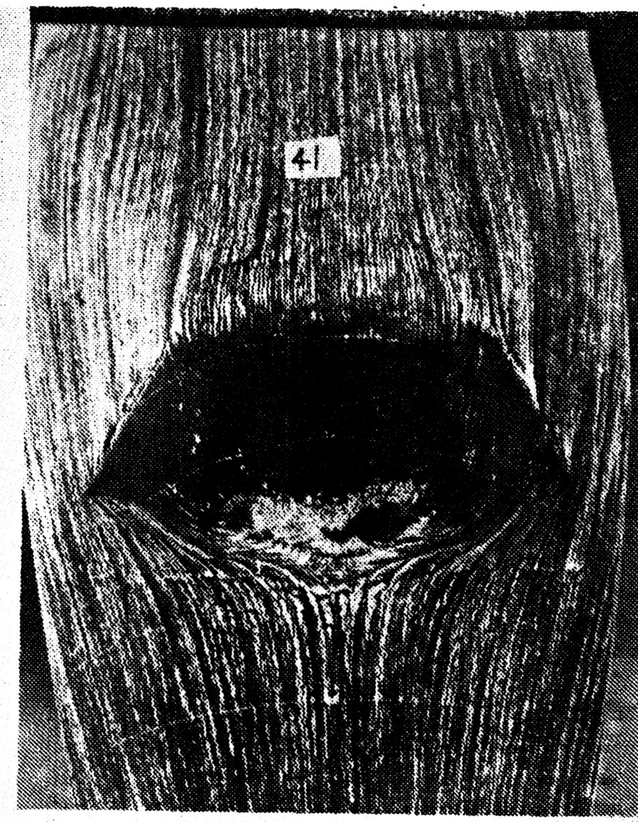


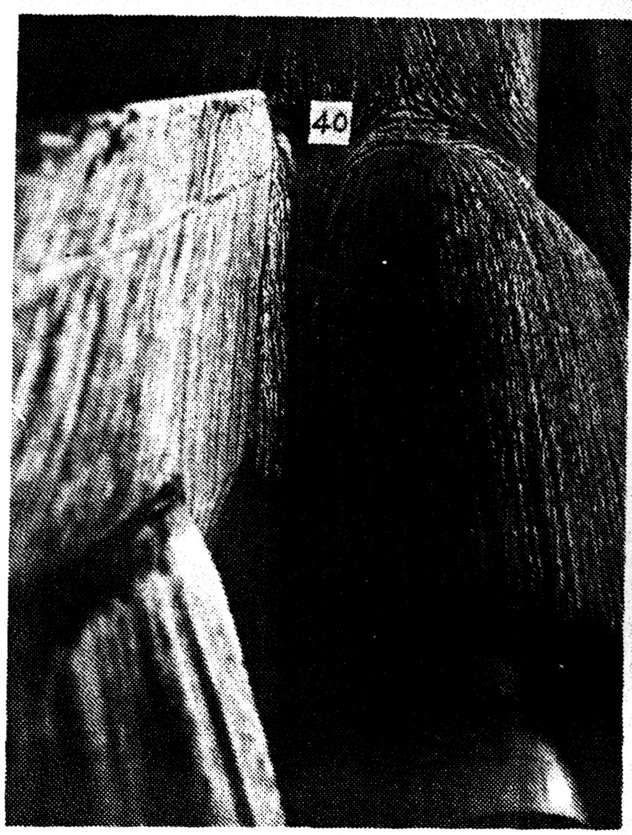
Run 40: Angle of Attack = 10 Degrees


40
40
40

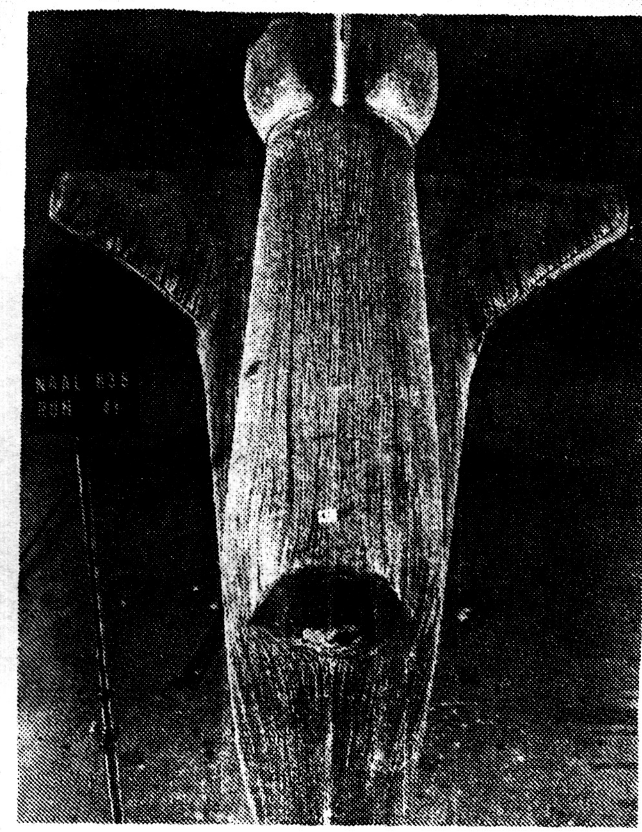


Run 41: Angle of Attack = 5 Degrees

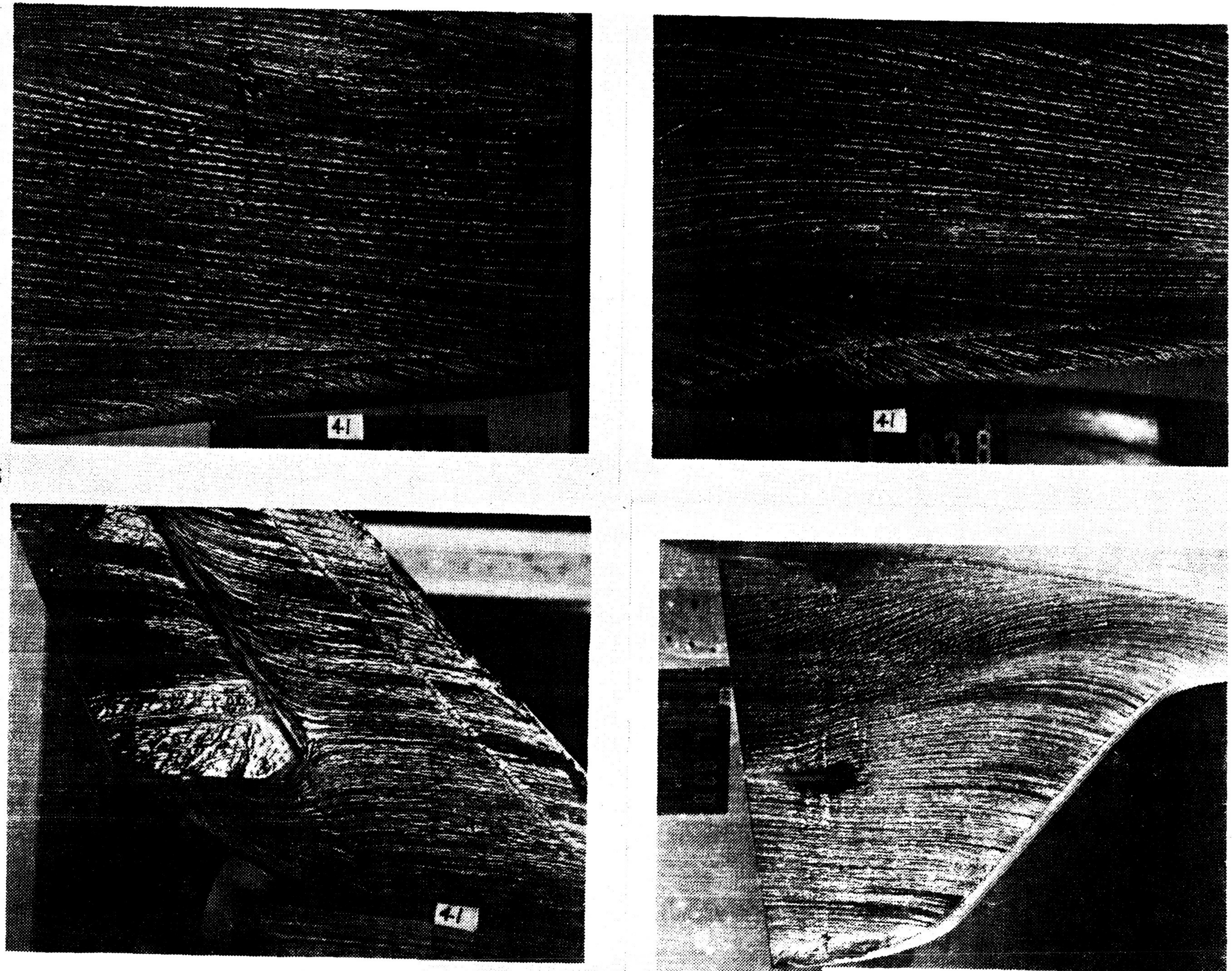




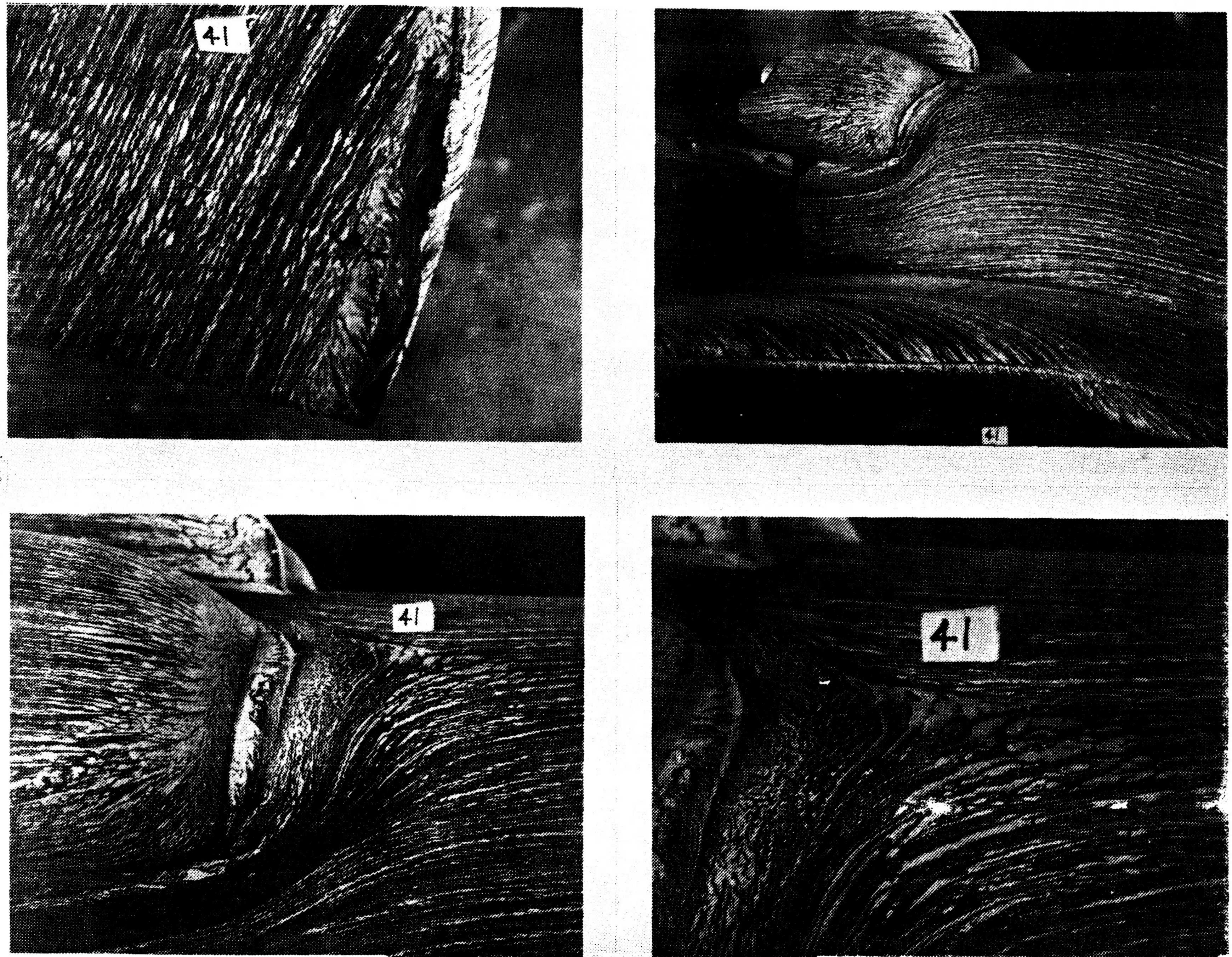
Run 40: Angle of Attack = 10 Degrees



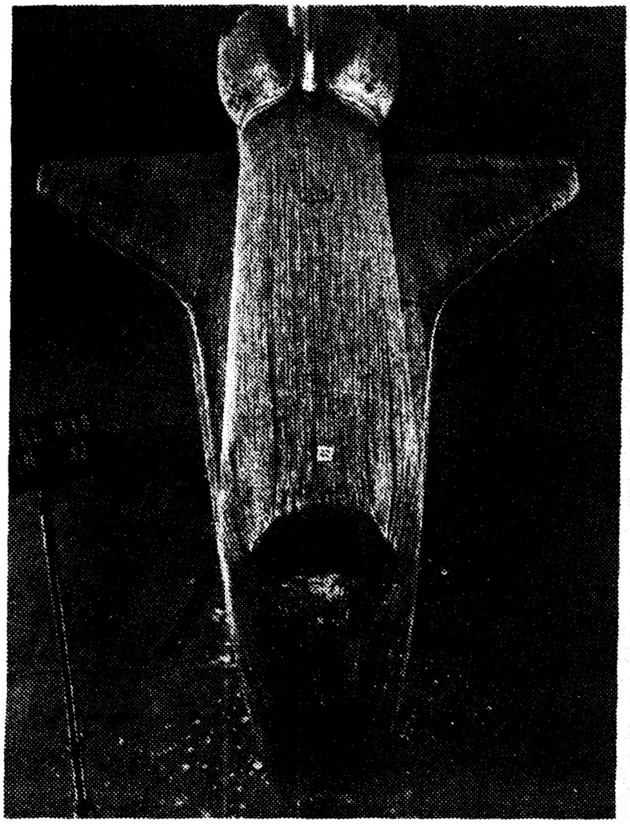
Run 41: Angle of Attack = 5 Degrees

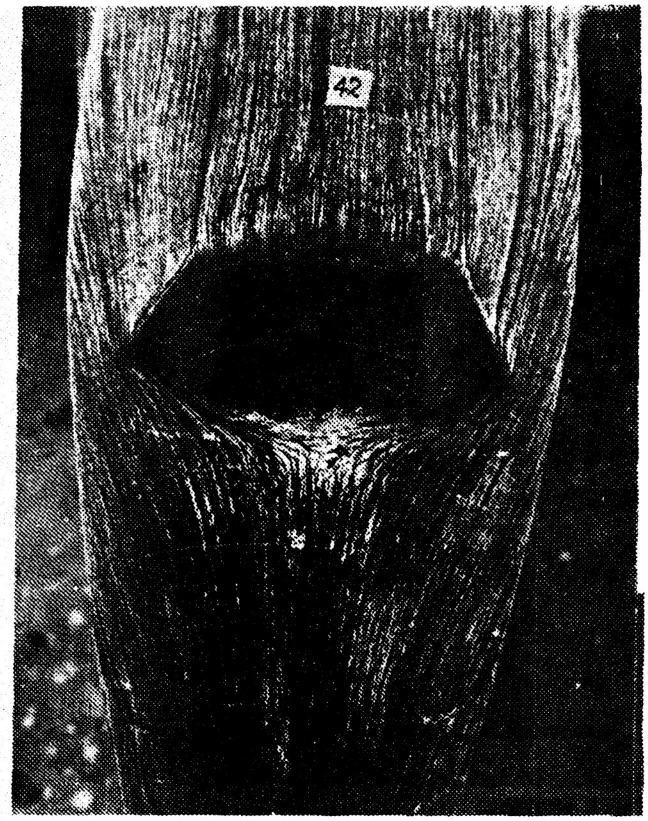


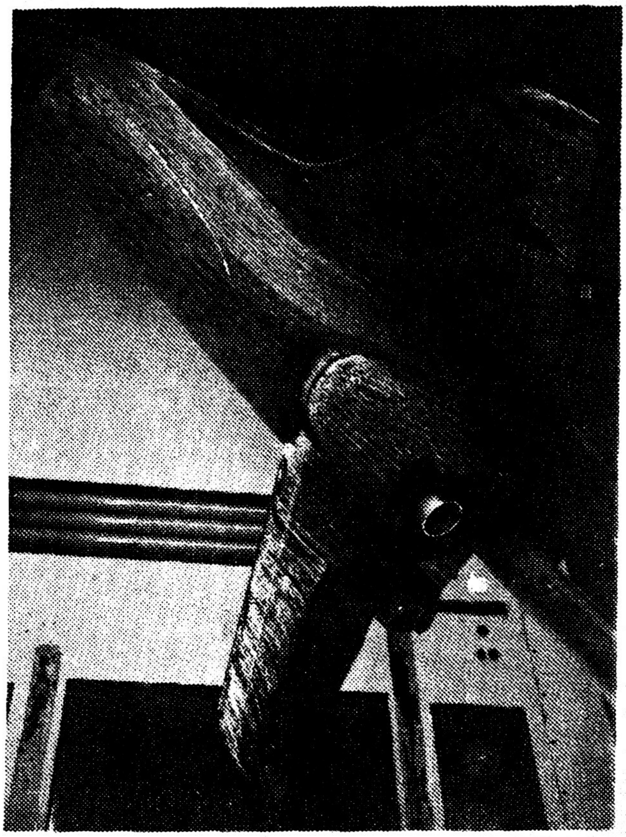
Run 41: Angle of Attack = 5 Degrees

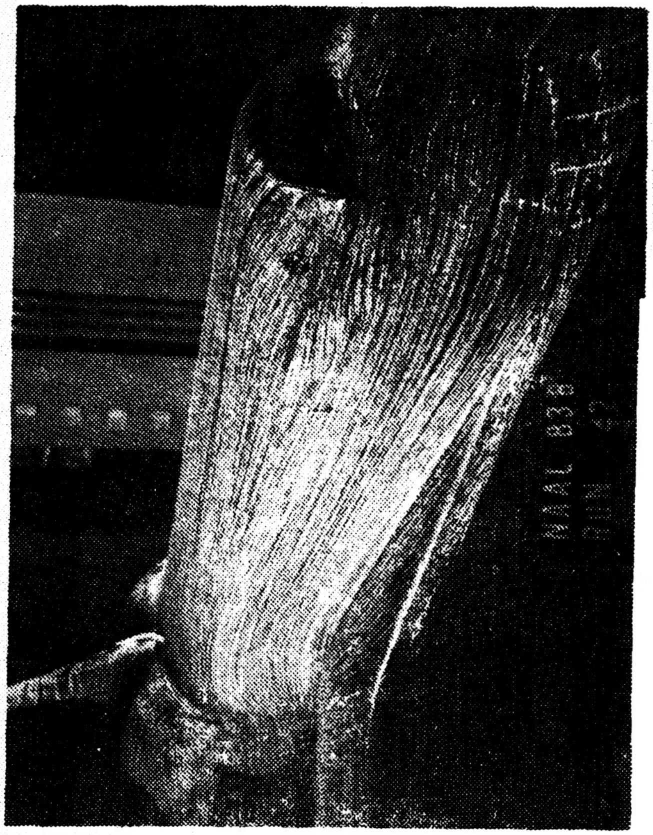


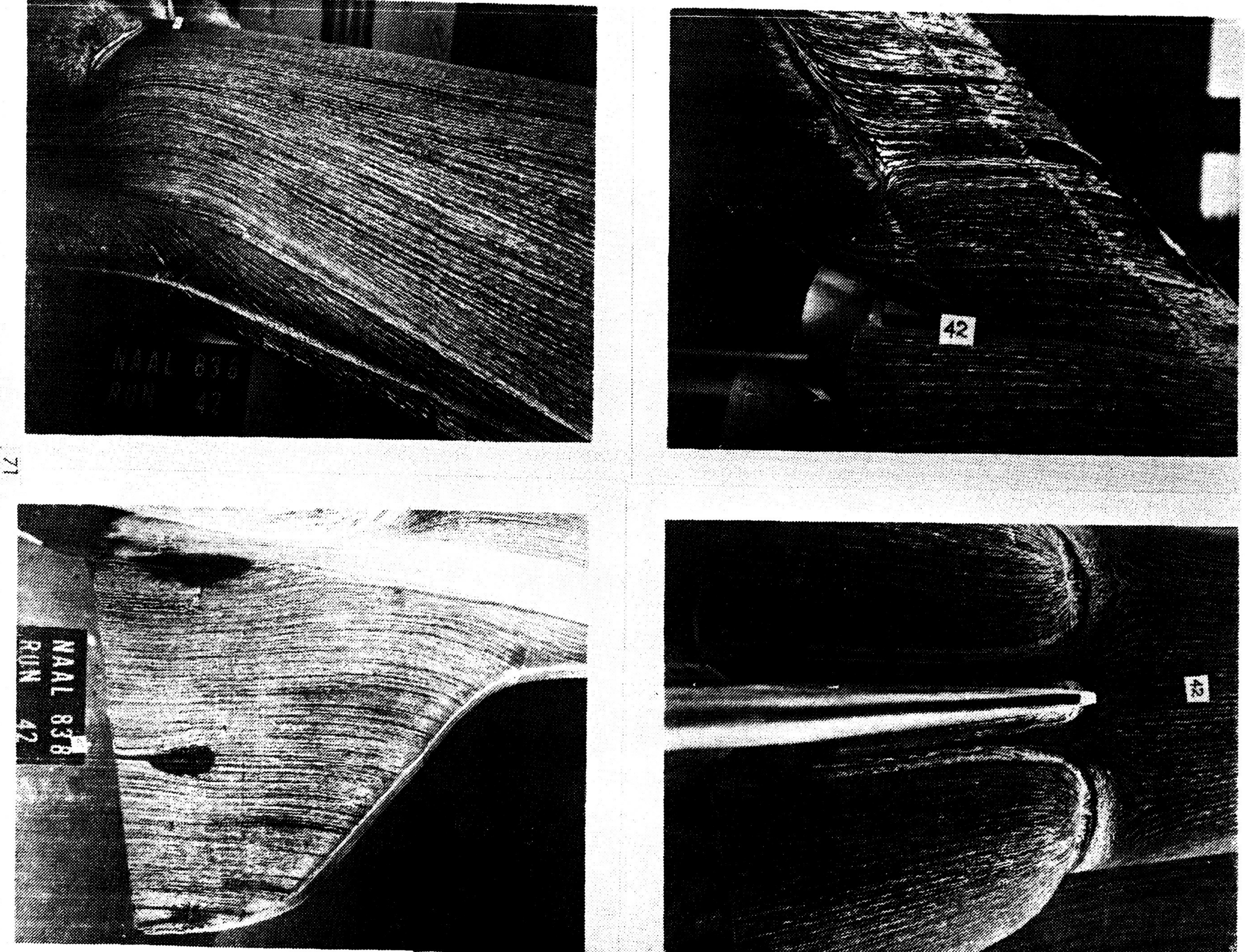
Run 41: Angle of Attack = 5 Degrees



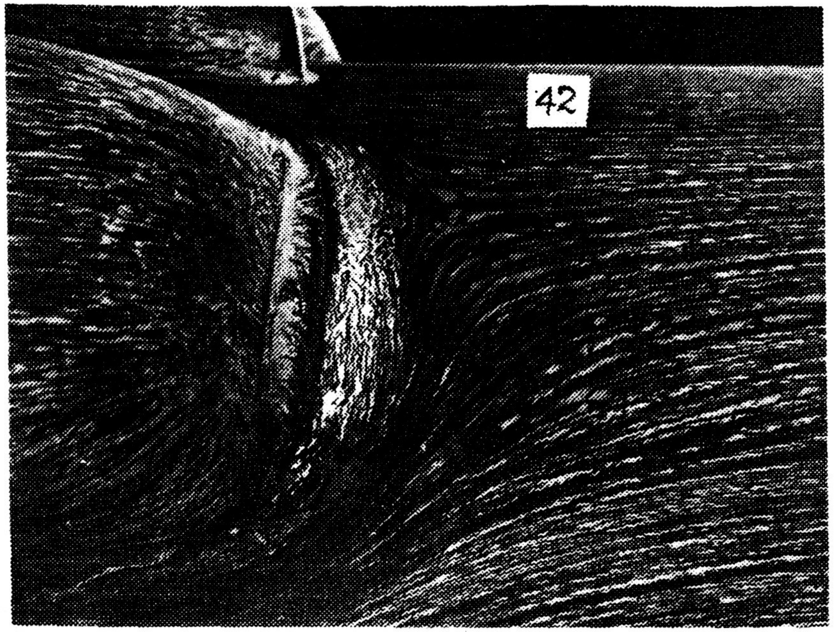

42

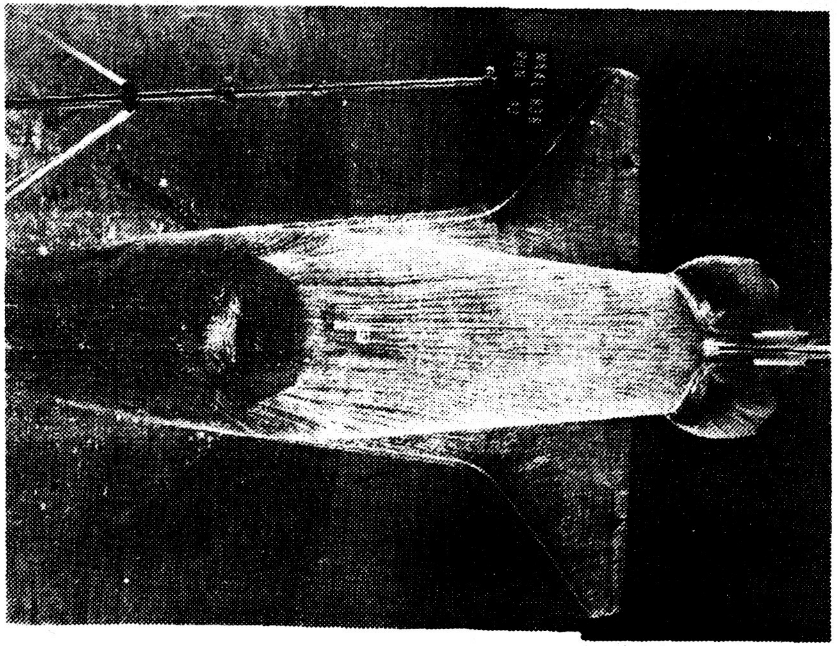




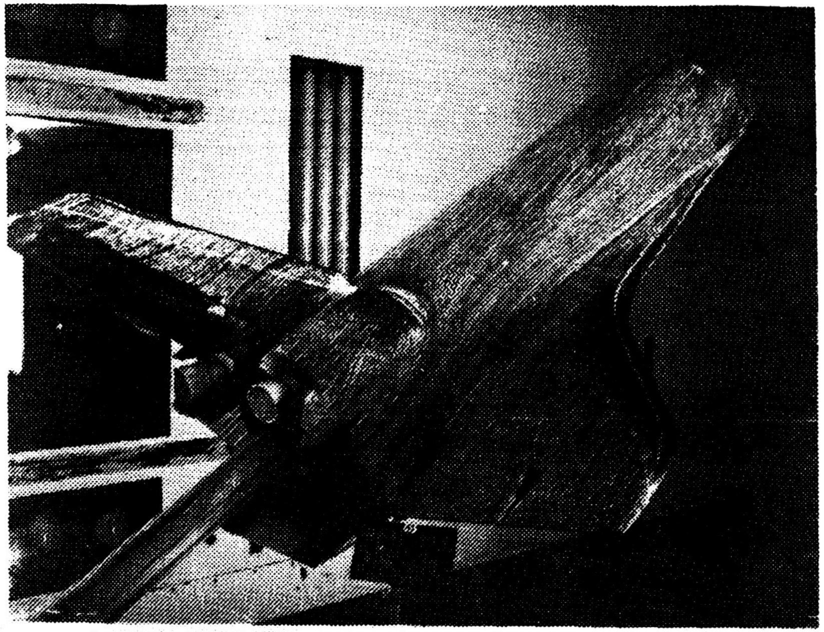


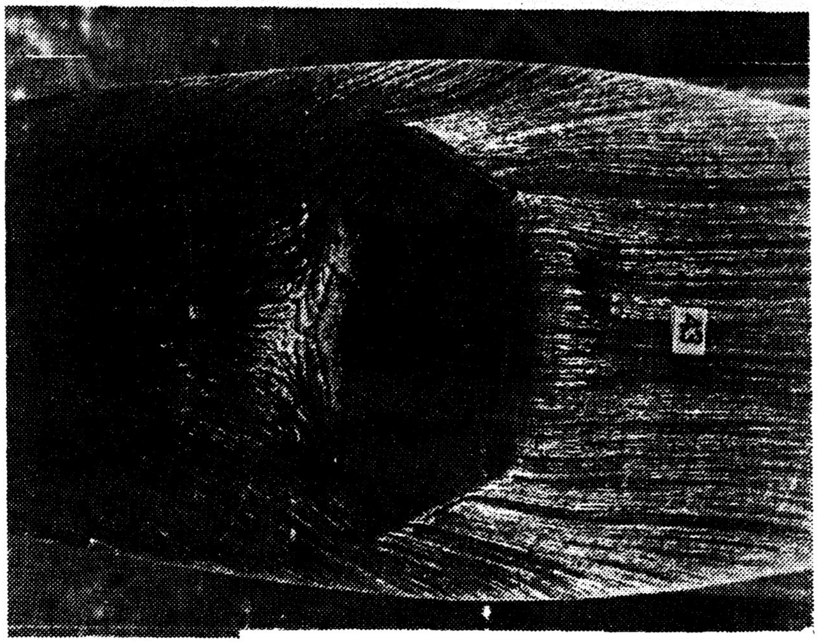
Run 42: Angle of Attack = 0 Degrees



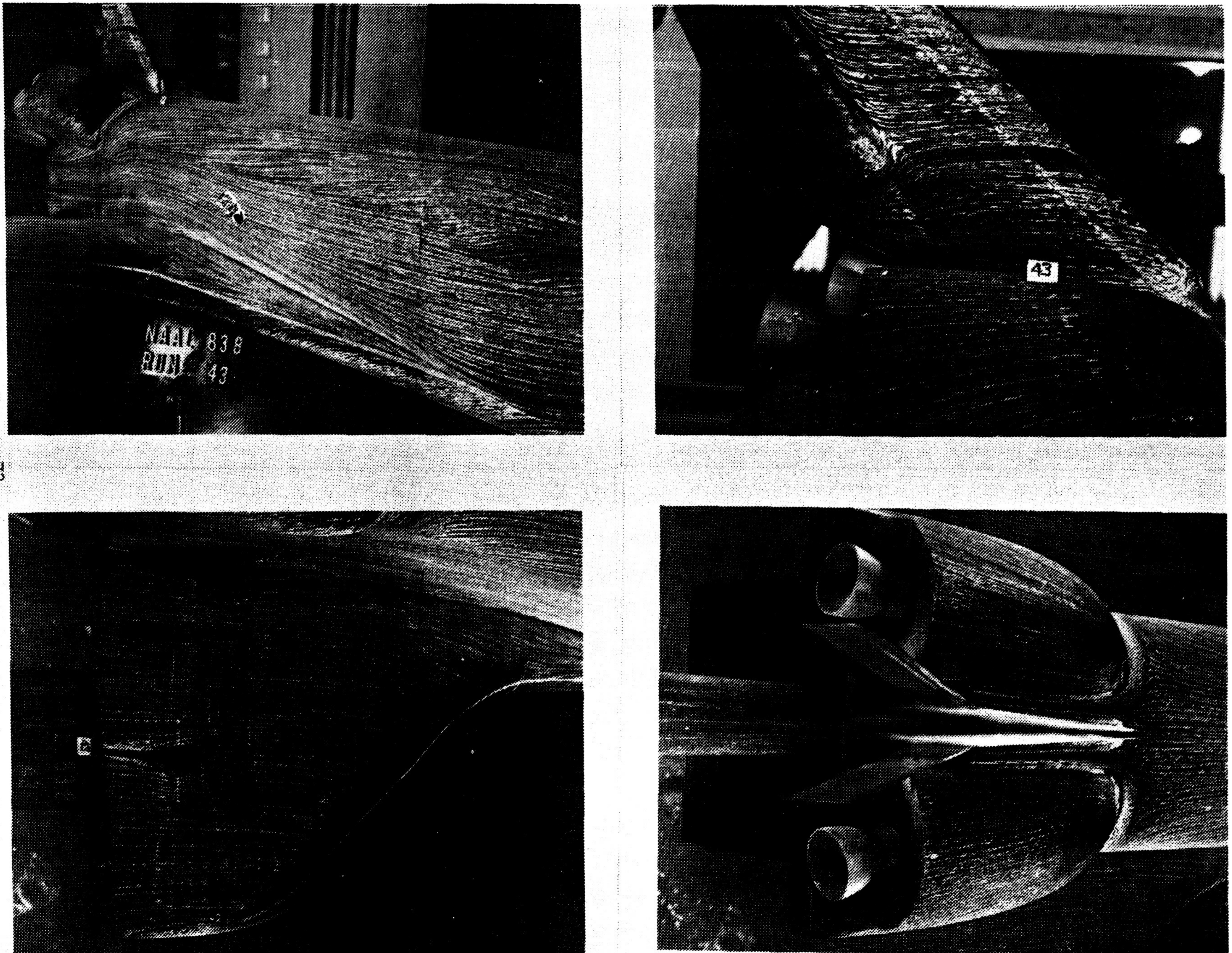


Run 42: Angle of Attack = 0 Degrees

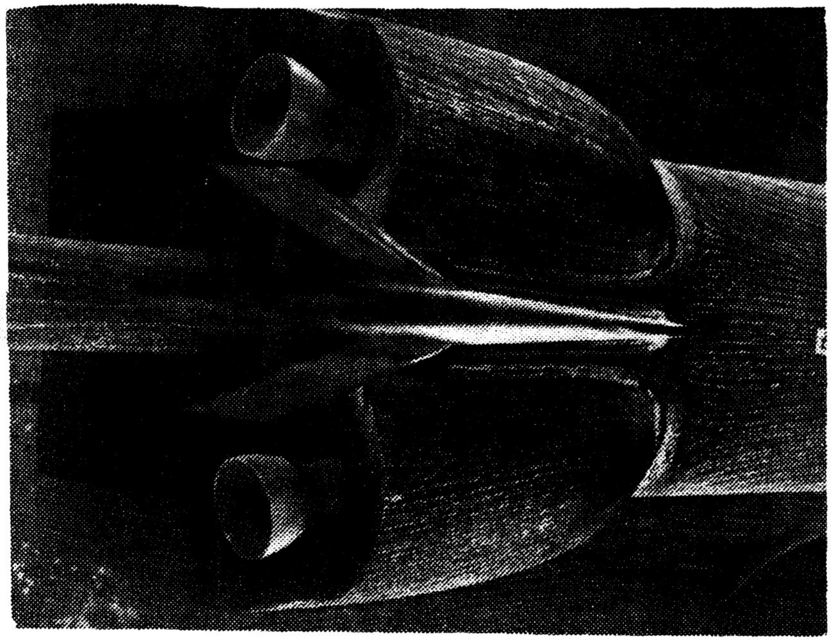


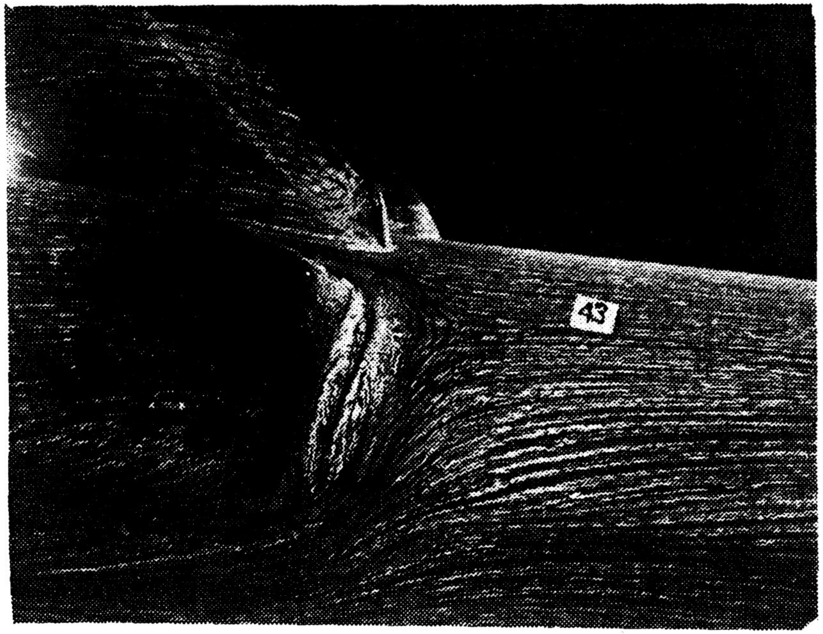


Run 43: Angle of Attack = -5 Degrees



Run 43: Angle of Attack = -5 Degrees





Run 43: Angle of Attack = -5 Degrees